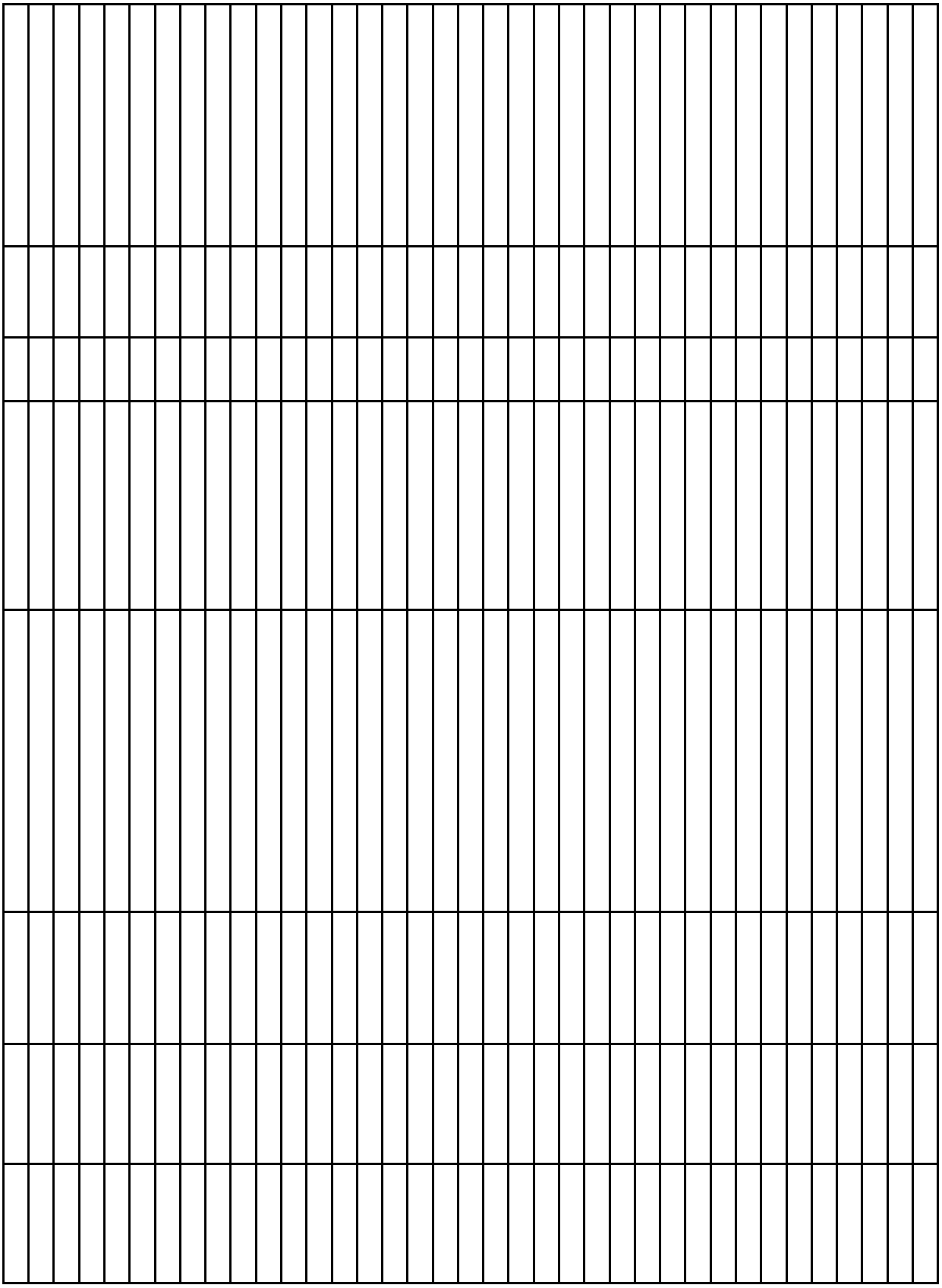
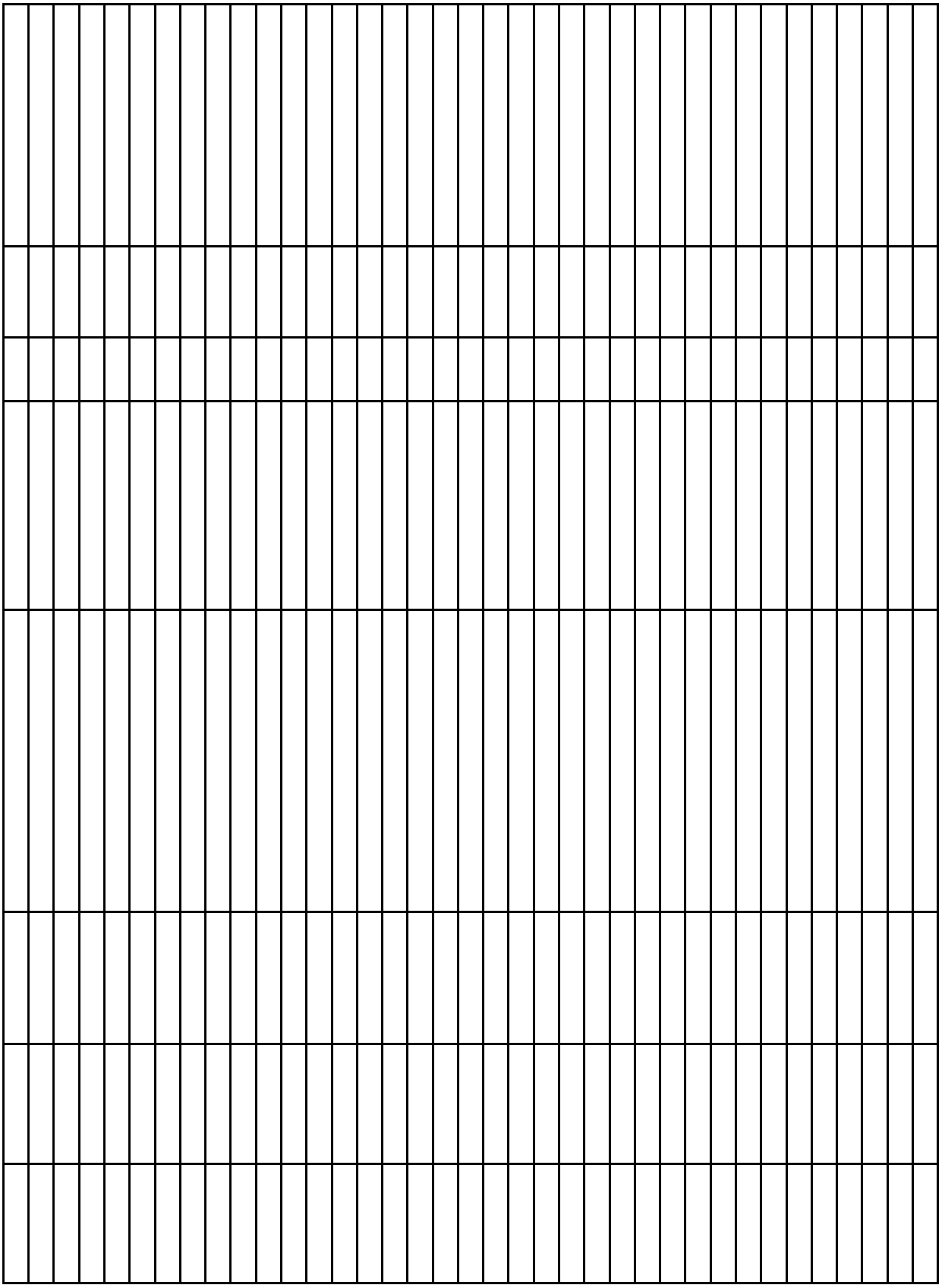
A-PDF MERGER DEMO

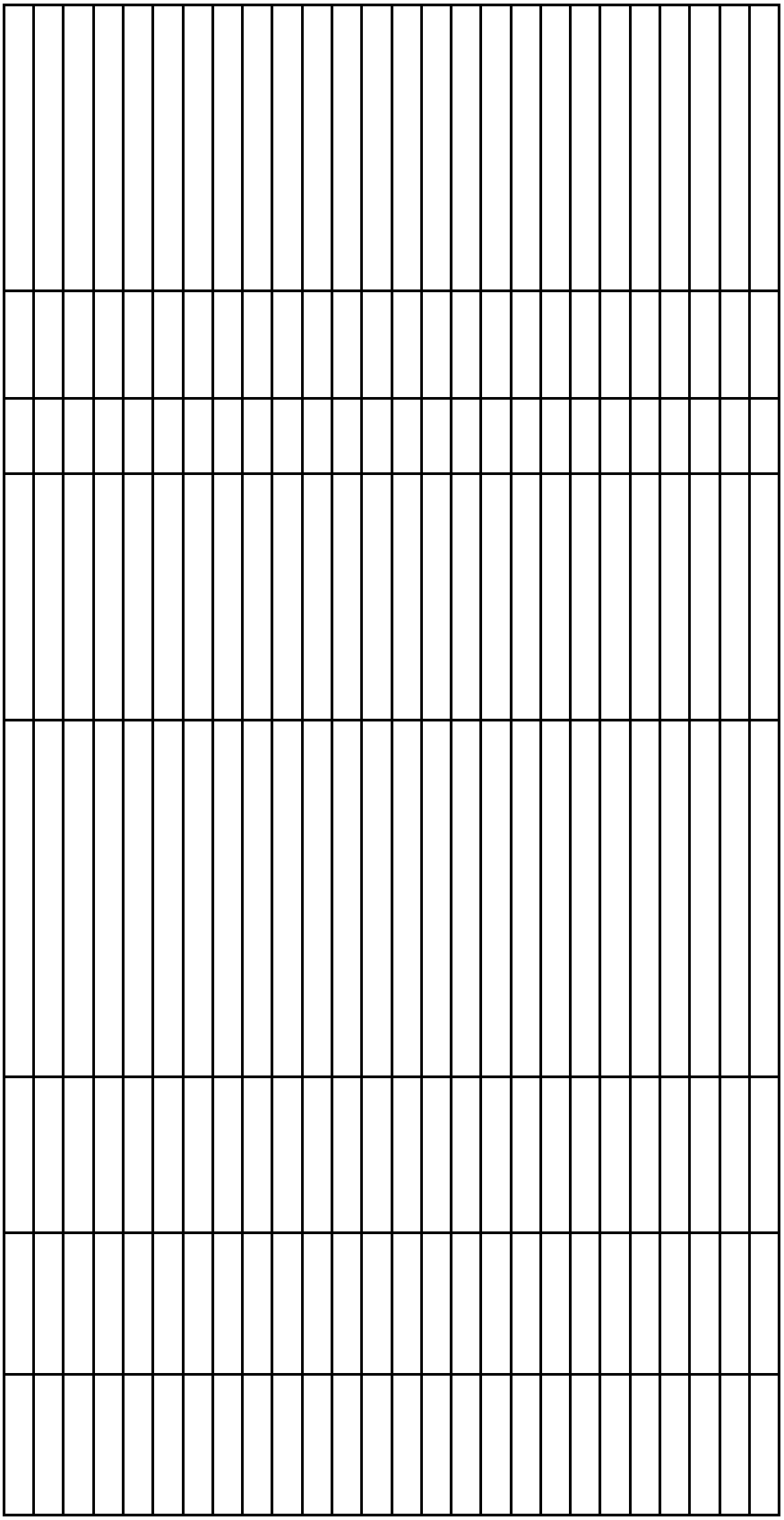
BIRDIE Electrical Data Package

A-PDF MERGER DEMO

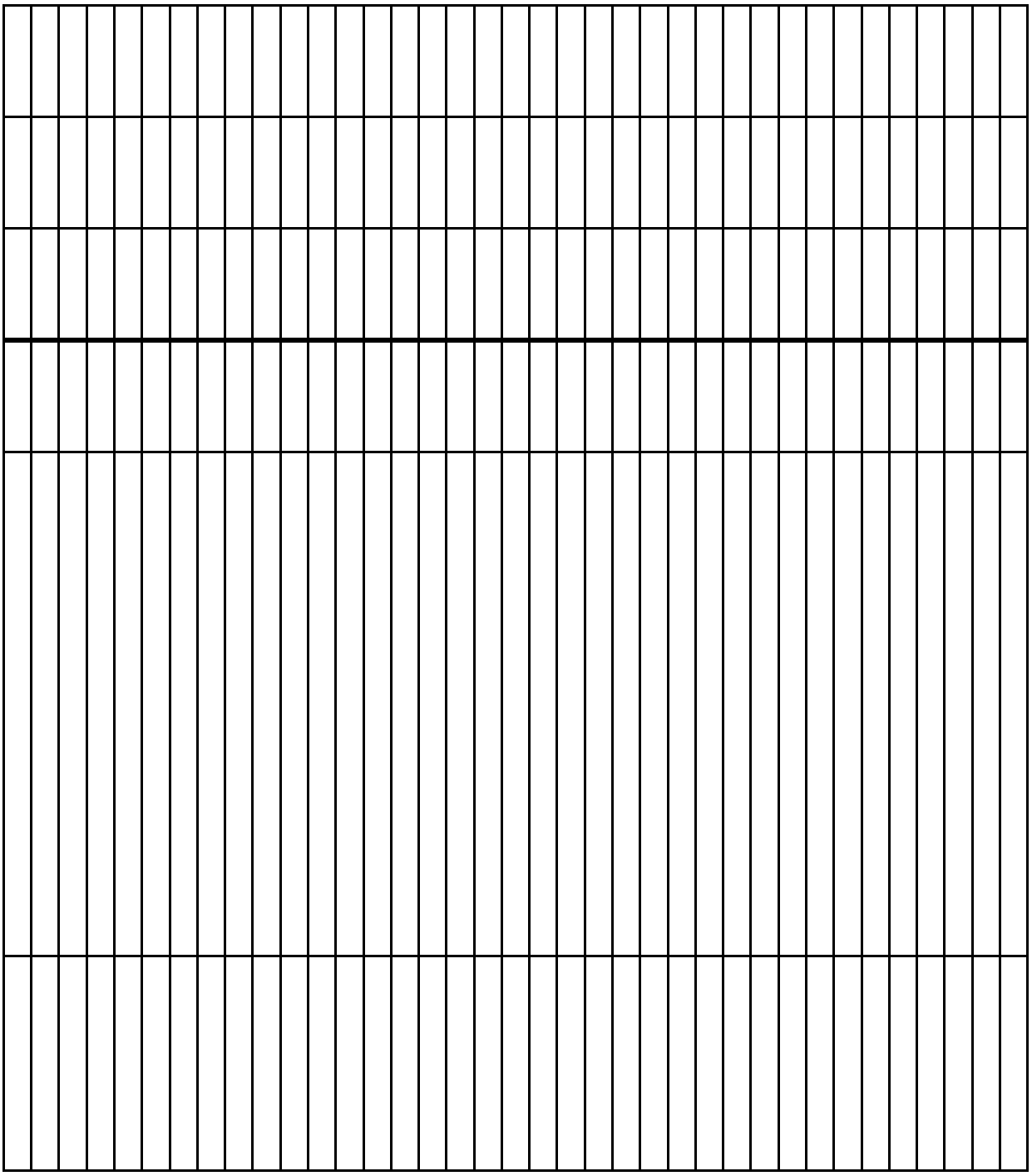
BIRDIE Electronics Tree							
Electronics Number	**Electronics Name**			**Dimensions**	**Quantity**	**Make/ Buy**	**Part Number**
01-000	Assembly, Wing Mechanism						
01-001		Wing Mechanism, Motion Controller		4.25"x7.0"	1	Buy	DMC-2133-DC24-BOX
01-002		Wing Mechanism, Amplifier		3.740"x4.849"	1	Buy	AMP20440
01-003		Wing Mechanism, Power Supply 1		5.25"x15.75"x19"	1	Supplied	1790
01-004		Wing Mechanism, Power Supply 2		3.937"x4.528"x4.933"	1	Buy	S8VS-24024
01-005		Wing Mechanism, Servo		2.125"x4.078"	3	Buy	14204S006
01-006		Wing Mechanism, Cable 1		1 M length	3	Buy	Cable-15-1M
01-007		Wing Mechanism, Cable 2		25 Ft	1	Buy	CC5e-B25B
02-000	Assembly, Visualization						
02-001		Visualization, Camera		3.37"x4.25"x8.25"	1	Supplied	V4.3
02-002		Visualization, Hard Drive		2.3"x5.6"x6.7"	1	Buy	WDG1U5000N
02-003		Visualization, Laser			1	Buy	AIX-532-1000
02-004		Visualization, Cable 1		25 Ft	2	Buy	CC5e-B25B

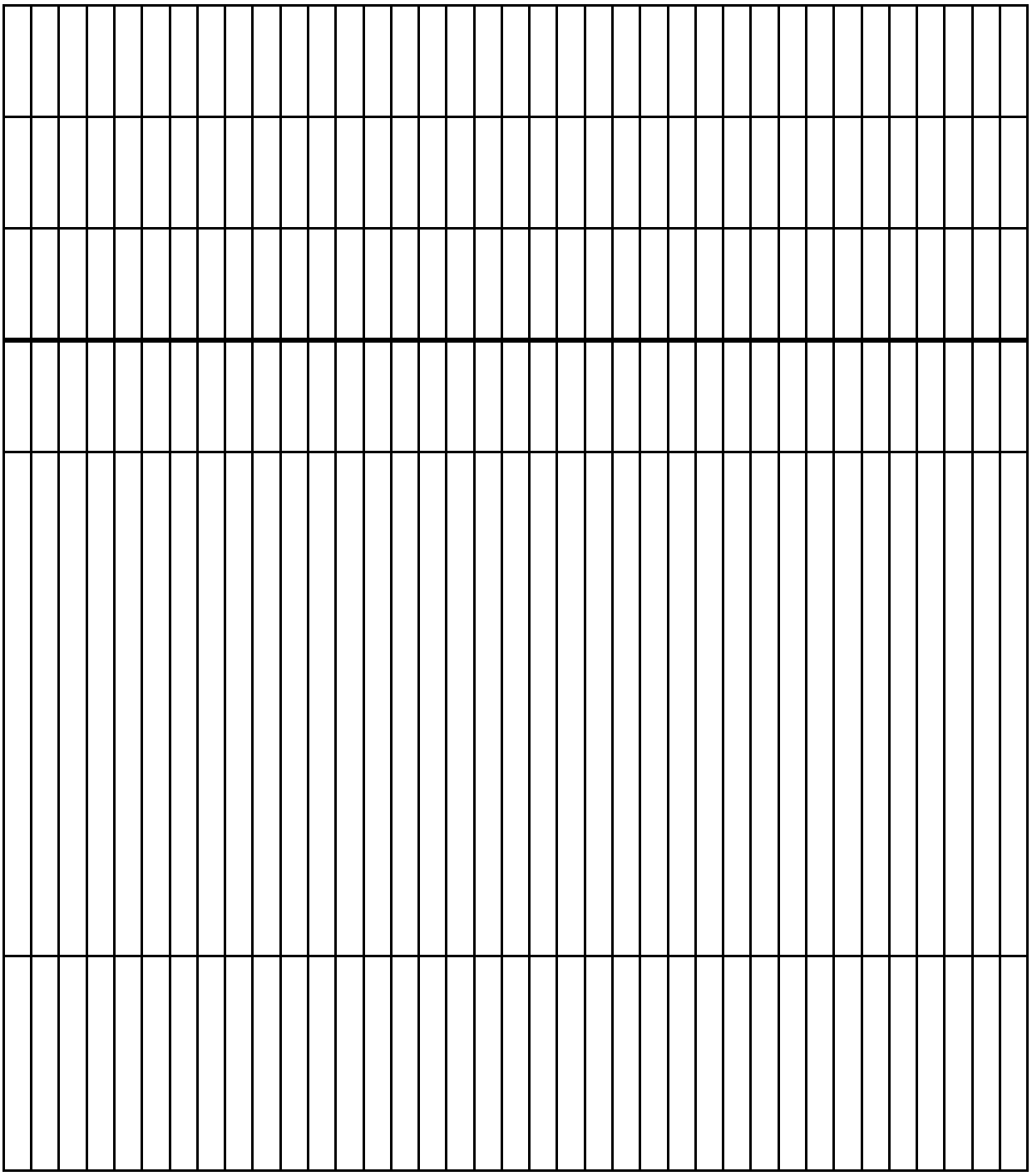


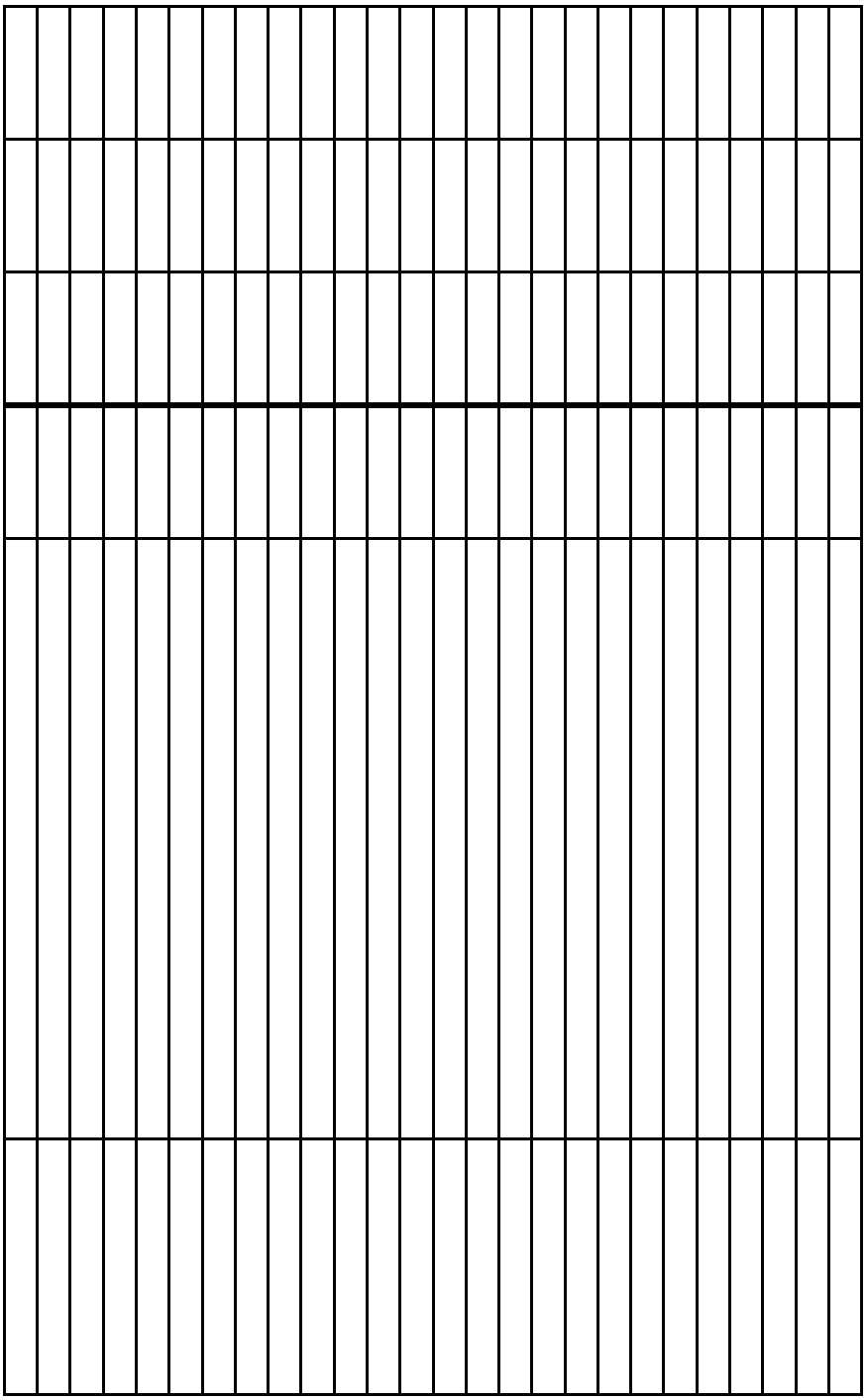


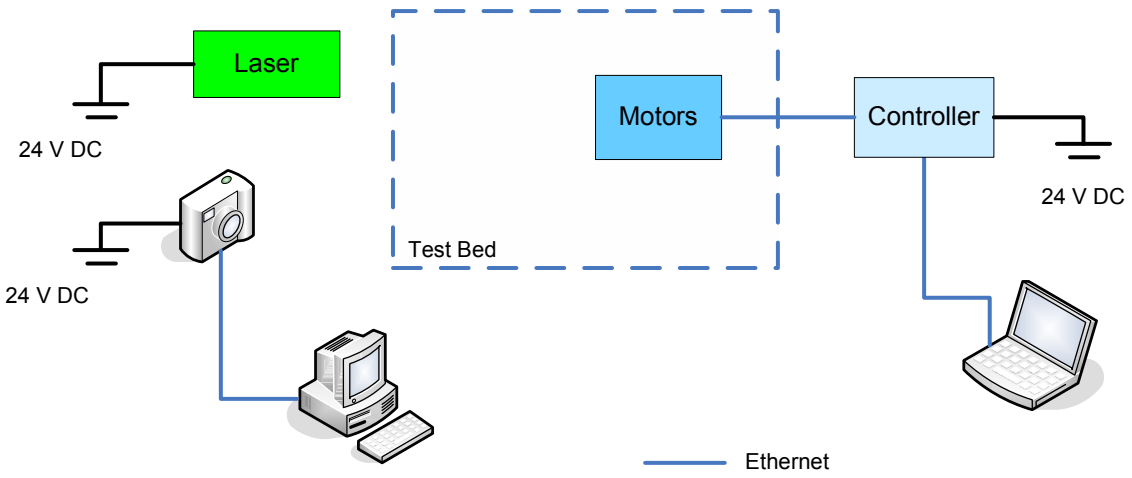


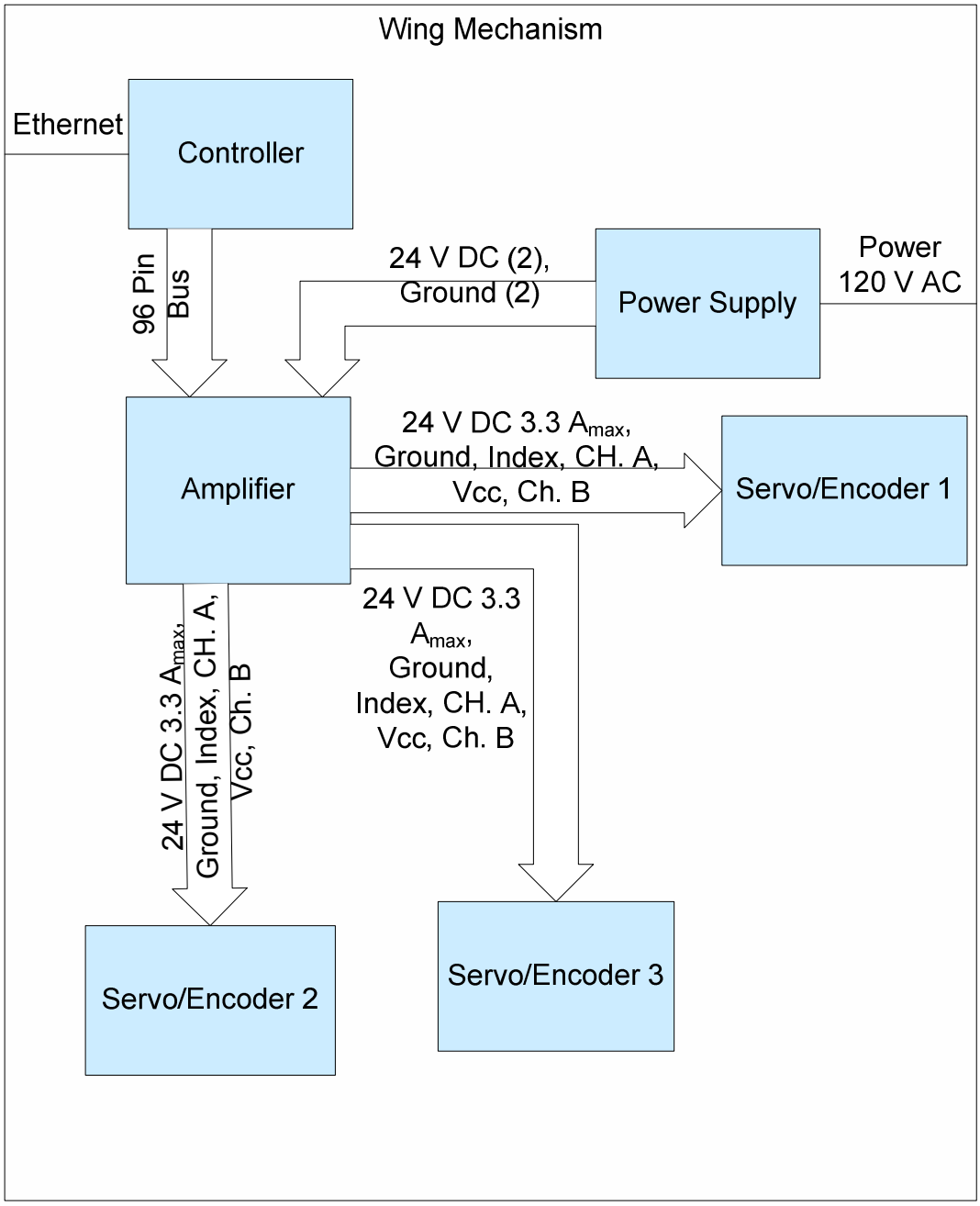
Manufacturer	Notes	Vendor	Unit Cost	Total Cost	
Galil Motion Control	4 Axis controller, 24 V DC	MSITec	$1,245.00	$1,245.00	
Galil Motion Control	4 Axis amplifier 24 V DC, 3.3 A/channel	MSITec	$595.00	$595.00	
BK Precision	DC Power Supply, 0-32 V DC, 0-20 Amp	Provided	$0.00	$0.00	
Omron	DC Power Supply, 24 V DC, 240 W	MSITec	$290.00	$290.00	(optional)
Pittman	Servo Motor, 24V DC w/ 500 line encoder	MSITec	$229.53	$688.59	
Galil Motion Control	15 Pin D-Sub to individual pin cable	MSITec	$25.00	$75.00	
AMC	Cat-5e cable	Newegg	$2.99	$2.99	
Phantom	High Speed Camera, 800x600 pixels, 1000 FPS	Provided	$0.00	$0.00	
Western Digital	External Hard Drive, 500GB USB 2.0	Newegg	$219.99	$219.99	
Aixiz Service and Inte	1000 mW Laser (532 nm)		$1,500.00	$1,500.00	
AMC	Cat-5e cable	Newegg	$2.99	$5.98	
		Total		$4,622.55	

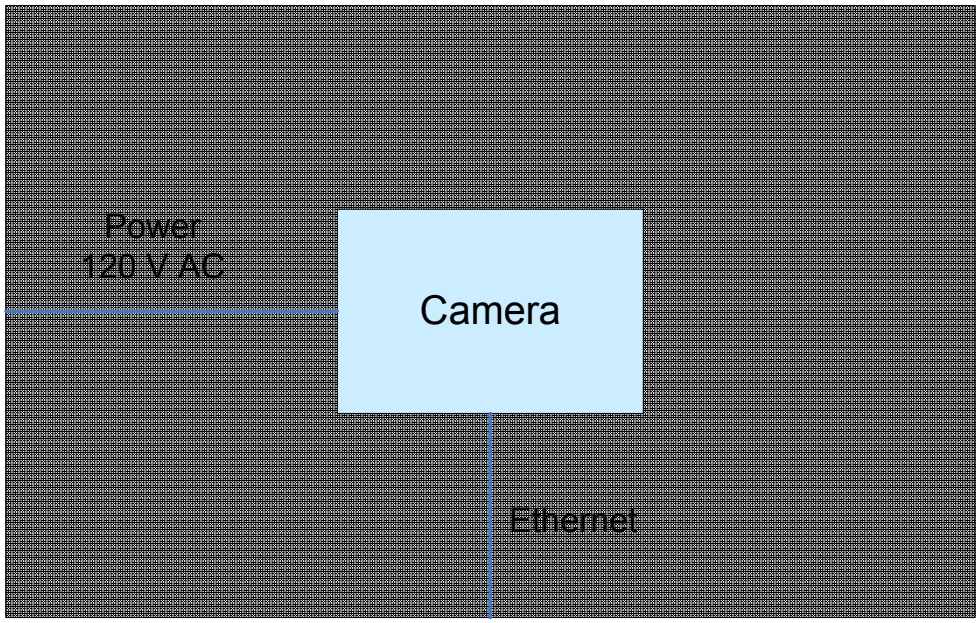







Laser
24 V DC
24 V DC
Test Bed
Motors
Controller
24 V DC
Ethernet


Wing Mechanism
Ethernet
Controller
96 Pin Bus
24 V DC (2), Ground (2)
Power Supply
Power 120 V AC
Amplifier
24 V DC 3.3 Amax, Ground, Index, CH. A, Vcc, Ch. B
Servo/Encoder 1
24 V DC 3.3 Amax, Ground, Index, CH. A, Vcc, Ch. B
24 V DC 3.3 Amax, Ground, Index, CH. A, Vcc, Ch. B
Servo/Encoder 2
Servo/Encoder 3


Power
120 V AC
Camera
Ethernet

High Current DC Power Supplies

Model 1790, 1791

High Current DC Power Supply

Models 1790/1791 are cost effective, high power, regulated DC power supplies with 640 Watt output. They are linear high current DC power supplies suitable for bench operation or standard 19" rack operation. These linear power supplies are high power workhorses that will easily deliver clean power to your high-current circuits.

1790

1791

Ideal for telecom application

Since noise elimination is critical for telecom application, the 1790 & 1791 DC power supplies offer low noise output, so that power supply noise does not interfere with testing of telecom devices. The 1790 & 1791 are ideal for manufacturers who build equipment for telecom industry that operates from 48V or higher DC rail such as: base stations, switches, public and private telecom network equipment, PBX system and DC to DC power supplies that provide power to this equipment.

These well-regulated constant voltage/constant current supplies deliver 0-32V at 0-20A (Model 1790) or 0-64V at 0-10A (Model 1791). They can be adjusted continuously throughout the output range by front panel controls. The units will automatically cross over from constant voltage to constant current mode and vice-versa if the output exceeds preset limits. Front panel LED meters are provided for monitoring voltage and current. The load terminals and remote sense terminals are located on the front panel. Either the positive or negative output terminal may be grounded or floated up to a maximum of ±300VDC above ground.

Special features include the ability to set constant current with no load and remote sense to compensate for any wire loss. The 1790 and 1791 are designed to meet CE specifications and have superior performance to comparable models costing 20 to 30% more.

- **Constant Voltage/Constant Current Operation**
- **Remote Programming Facility**
- **Facility for Presetting the Output Voltage and Max. Load Current Limits**
- **Separate DC Output ON/OFF Switch**
- **Remote Sensing Facility**
- **High Stability and Close Regulation ±0.01%**
- **Meet CE Specifications**

Specifications

	models 1790	1791
Output (DC)	0-32V	0-64V
Output Current (DC)	0-20A	0-10A
Constant Voltage Mode		
Line Regulation (120V±10%)	±0.01% ± 2mV	
Load Regulation	±0.01% ± 2mV	
Ripple and Noise	≤1mV rms max	
Constant Current Mode		
Line Regulation (120V±10%)	±0.05% ± 10mA	
Load Regulation	±0.05% ± 10mA	
Ripple and Noise	6mA rms Max	
Overload Protection	Constant current type	
Stability	± 0.2% ± 10mV in CV mode ± 0.5% ± 10mA in CC mode	
Operating Temperature	32° to 104°F (0° to 40°C)	
Power Requirement	120/230V, 60 Hz ±10%	
Dimension (W x H x D)	19 x 5.25 x 15.75" (483 x 133 x 400mm)	
Weight	62 lbs. (28.1 kg)	

Accessories

Two Year Warranty

SUPPLIED: User Manual
OPTIONAL: TL-30 Hook up leads

v4.3
Specifications

Features

Auto Exposure
"EDR" Extreme Dynamic Range™
HYGE configuration (optional)
Continuous recording
Pre-trigger recording
Post-trigger recording
On chip global shuttering
Strobe sync
Segmented image memory
Continuous color video output
IRIG-B timing capture with phase shift
10/100/Gigabit Ethernet

Sensor: 800 x 600 pixel SR-CMOS sensor.

Image Bit Depth: 10-bit

Sensitivity: 4800 ISO/ASA mono-chrome, 1200 ISO/ASA color

Pictures per Second (PPS): Full sensor; to 1,000pps

Exposure Time: Variable, independent of sample rate, to 10 microseconds (2 microseconds option)

Trigger: Continuously variable pre/post

Imager Control: 10/100/Gigabit Ethernet, or RS232 serial interface

Preview and Focusing: Via computer monitor or continuous video out

Lens Mounts: 1" C-mount standard. Many other lens mounts available, including Nikon

Inputs/Outputs: via integrated quick-release connector:

Trigger: Rising/falling TTL pulse w/filter, or switch closure

Sync Image: TTL pulse

Event Marker: TTL pulse or switch closure

Ready Signal: TTL pulse

IRIG-B Timing: IRIG-B code, modulated or unmodulated input, with IRIG-B output, lock, and variable phase shift

Strobe Sync: TTL Pulse

RS232

Network: 10/100/Gigabit Ethernet

Video out: RS-170 (NTSC, PAL), and SDI (Serial Digital Interface)

Power: 24VDC/1.0 Amp

MEMORY

Standard: 256 Megabytes integral image memory. Records 512 images for 0.5 second of continuous recording at 1,000pps, full format. Longer recording times for lower sample rates and allocated formats (example: 5 seconds at 100pps).

Optional: Up to 2,048 megabytes of integral image memory. Records 4,096 images for 4.0 seconds continuous recording at 1,000pps, full format. Longer recording times for lower sample rates and allocated formats (example: 40 seconds at 100pps).

Optional: Non-Volatile Flash Memory, up to 6 gigabyte (recommended for all HYGE applications)

ENVIRONMENTAL

Ambient Temperature
32°F and 104°F (0°C and 40°C)

Maximum humidity: 80%, non-condensing, at 5°C

SOFTWARE

Phantom® operates in a Windows environment with familiar commands found in familiar places. Standard functions include:

Acquisition: Image capture, IRIG-B timing capture & standard time annotation. Field of view & focus. Sample rate & aspect ratio selection. Shutter speed. Histogram. Brightness, contrast, & gamma adjust. Trigger modes. Continuous record. Save & recall setups.

Analytical playback: Immediate playback of cine. Variable playback speed in forward or reverse, including freeze frame & endless loop. Random Go-to-Image. View single images at random from any cine. Tile/cascade multiple images on one screen. Timing data displayed with each image. Cine editor. Multi Cine Viewer.

Measurements: Linear or angular measurements. Displacement. image. English and metric units. Generate Velocity. RPMs. 100 data points per measurement reports. Report files & images are compatible with spread sheet software, and image analysis software such as TrackEye®, Image Express®, or Falcon®.

Image processing: Smooth, sharpen, psuedocolor, negative image, and edge detection. Brightness, contrast & gamma adjust. 3x3 and 5x5 filter matrix for custom image processing.

File management: Organize, save, compress and export cines, or single images. File formats are compatible with most word processing, desktop, publishing, and presentation software.

DIMENSIONS

Size: 4.25 x 3.37 x 8.25 inch (HWD) (10.8 x 8.56 x 20.96 cm) (HWD)

Weight: 4.5 lbs (2.0kg)

Power: 24VDC/1 Amp

Mounting: 1/4-20 inch and four 10-32 threaded hole pattern in base and top

Mounting Axis: Any position

Material & Finish: Machined aluminum housing, plated finish

Country of Origin: The United States of America

STANDARD ACCESSORIES

Phantom® software, Single user license*

256 Megabyte integral image memory

Ethernet, Sync output pulse, trigger, pretrigger, video out, and IRIG-B

110/220VAC -24VDC International Power Adapter, 12 foot (3.7 m) power cord

One year warranty

QUESTIONS?

For technical assistance, systems integration, custom options, or information on imaging techniques or training please call us tool free:

1.800.RESOLUTION

(US & Canada 1.800.737.6588)

For the most up-to-date information, specifications and options, please visit our website:

www.visionresearch.com

VISION RESEARCH

Specifications and features subject to change without notice.

(Other options available) Phantom is manufactured in the USA under US Patent Number 5625412 and patents pending. Phantom®, EDR®, and Memory Gate® are registered trademark of Vision Research Inc. Windows™ and Windows logo are trademarks of Microsoft Corporation.*

Vision Research, Inc. • 100 Dey Road • Wayne, New Jersey 07470 USA • (973) 696-4500 Fax (973) 696-0560

Rev 11/9/06

General Description

Command Language

Galil's Command Language is comprised of intuitive, two-letter, English-like ASCII commands that make programming as quick and easy as possible. For example, the "BG" command begins motion while the "SP 2000, 4000" command sets the speed of the X-axis as "2000" and the Y-axis to "4000". Commands are included for system set-up, tuning, prescribing motion, error handling and application programming. Custom commands can be created upon request.

One of the more powerful features of all Galil controllers is their ability to store and execute complex application programs designed by the user. Application programs can be downloaded directly to the controller and executed without host intervention. The main benefit is that this frees the PC for system-level tasks. In fact, Galil controllers permit multitasking, which allows up to eight programs to execute simultaneously. Also, special commands are available for application programming including event triggers, IF/THEN/ELSE statements, conditional jumps, subroutines, symbolic variables and arrays.

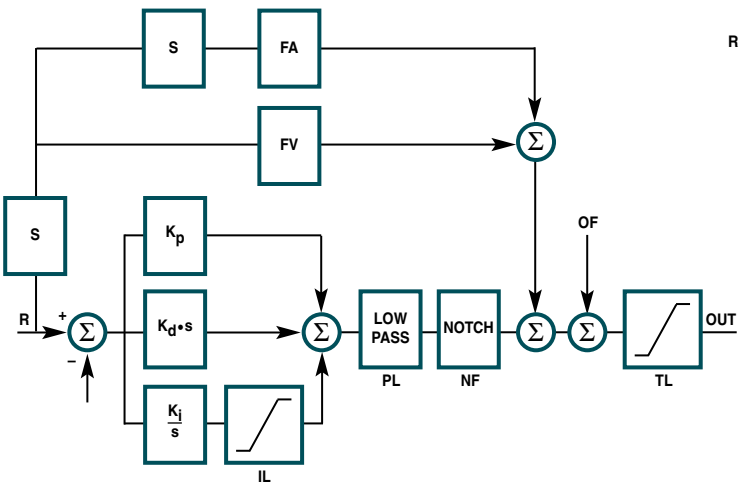
Servo Motor Compensation Features

Galil controllers provide a compensation filter, which includes a PID (Proportional-Integral-Derivative) filter followed by a notch filter and a low-pass filter. The compensation also includes velocity and acceleration feedforward. All filter parameters are adjustable, allowing servo system tuning for best performance. Dual loop control is provided for reducing the effect of backlash.

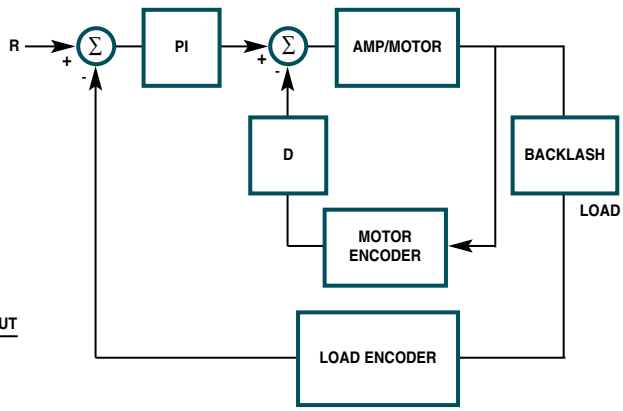
The dual-loop (DV) feature enables the controller to compensate for mechanical backlash. Typically, dual-loop systems use a rotary encoder on the motor and a linear encoder on the load (most Galil controllers accept inputs from two encoders per axis as a standard feature). Dual-loop control changes the standard PID control and closes the position loop with the load encoder ("PI") and derives the damping terms ("D") from the motor encoder. This method provides smooth and accurate control along the motion path regardless of backlash.

Most Galil controllers also include a sinusoidal commutation feature that allows designers to use lower-cost servo drives. This feature assures smooth motion and reduces torque ripple when using brushless motors. Each axis of sinusoidal commutated motion requires two DAC outputs that are phase shifted by 120°. The servo amplifier generates the third commutation signal. The commutation can be initialized with or without hall sensors. Two controller axes are required for each brushless motor. For example, a two-axis controller is required to drive one brushless motor with sinusoidal commutation.

PID Block Diagram



Dual-loop Block Diagram



General Description

Modes of Motion

Point-to-Point Motion

Any combination of axes can be operated in the Point-to-Point Motion mode to allow the target position (PA or PR), slew speed (SP), acceleration (AC) and deceleration (DC) to be specified independently for each axis. That way, motion on any axis can be started and stopped independently. Upon begin (BG), the controller generates a trapezoidal velocity profile where the speed and acceleration can be changed anytime during motion. For applications that require smooth motion without abrupt velocity transitions, a motion smoothing function (IT) is provided. The position (TP) and position error (TE) may be interrogated at any time.

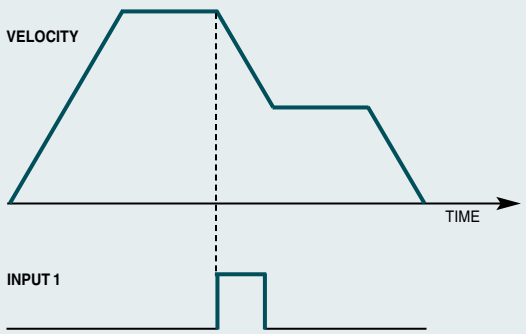
Example—Point-to-Point Motion

COMMAND	INTERPRETATION
AC 1000000	*Specify acceleration*
DC 1000000	*Specify deceleration*
SP 20000	*Specify slew speed*
PR 40000	*Specify distance*
BG	*Begin motion*

Example—Change Speed on Input

Move the x-axis forward a distance of 20000 counts at an initial speed of 50000 counts/sec and with an acceleration and deceleration of 1000000 counts/sec^2. As soon as the motor activates the sensor connected to input 1, reduce the speed to 25000 counts/sec.

PROGRAM	INTERPRETATION
#A	*Label*
PR 20000	*Distance*
SP 50000	*Initial speed*
AC 1000000	*Acceleration rate*
DC 1000000	*Deceleration rate*
BGX	*Start the motion*
AI 1	*Wait for the sensor input*
SP 25000	*Reduce the speed*
EN	*End program*



Position Tracking

The Position Tracking mode allows an axis to precisely follow a randomly generated position target. In this mode, a new absolute position may be specified even if the axis is in motion. The controlled axis is commanded to move to the new position following a trapezoidal velocity profile.

The (PT) command places the controller in the Position Tracking mode, which allows the host to issue absolute position commands on the fly. The axis moves to the new position and waits until a new position target is specified and given by the (PA) command. The (ST) Stop command is used to exit the Position Tracking mode.

Jogging

In the jog mode, each axis is given a jog speed and direction (JG), acceleration (AC), and deceleration (DC). Upon begin (BG), the controller ramps up to the jog speed at the prescribed acceleration following a trapezoidal profile. A smoothing function (IT) is provided to smooth abrupt velocity transitions. The stop command (ST) stops the motion at the prescribed deceleration rate. The jog speed and direction, acceleration and deceleration may be changed at any time during motion. The average speed can be interrogated at any time using the Tell Velocity (TV) command.

Example—Velocity Control by a Potentiometer

To control the motor velocity by a potentiometer, connect the potentiometer to analog input #1 and read its voltage. Set the motor speed in proportion to the analog input with a maximum speed of 100,000 counts/sec for a 10 Volt input. Also, limit the acceleration and deceleration to 500,000 counts/sec^2.

COMMAND	INTERPRETATION
#A	*Label*
JG 0	*Initial speed*
AC 500000	*Acceleration*
DC 500000	*Deceleration*
BGX	*Begin motion*
#LOOP	*Label*
JG@AN[1]*10000	*Read potentiometer and update speed*
JP#LOOP	*Repeat*
EN	*End program*

General Description

2D Linear and Circular Interpolation (for controllers with two or more axes)

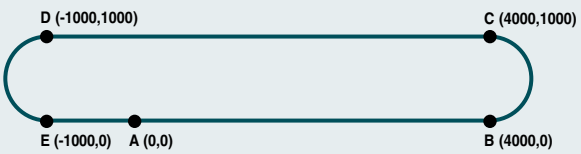
The Vector Mode (VM) is an extremely powerful mode where any two-dimensional path consisting of straight-line (VP) and arc segments (CR) can be prescribed. Up to 511 segments can be given prior to the start of motion and additional segments can be sent during motion allowing unlimited motion paths to be followed without stopping. The vector speed (VS), vector acceleration (VA), vector deceleration (VD), and motion smoothing (VT) are also prescribed. The vector speed can be changed at any time during motion, permitting feedrate override, slow down around corners and assignment of different speeds to specific segments. Setting the vector speed to zero and increasing the vector speed to resume can easily accomplish a pause during motion.

The vector mode can be operated on two sets of coordinated axes at the same time using the (CA) command, which specifies the plane of motion as S and T. By having dual sets of coordinated motion, users can accomplish completely separate coordinated motion tasks with a single controller. It can even handle more complex motion control functions such as collision avoidance.

Example—Coordinated Motion

Perform a move along the trajectory shown in the figure starting at the point A and move counter clockwise toward B. Set the vector velocity to a uniform rate of 5000 counts/sec, and set the accel/decel rate along the vector to 500000 counts/sec^2.

COMMAND	INTERPRETATION
#PATH	*Label*
CAS	*Set coordinate system*
VMXY	*Define plane as XY*
VA 500000	*Acceleration*
VD 500000	*Deceleration*
VS 5000	*Vector speed*
VP 4000,0	*Move AB*
CR 500,-90,180	*Move BC*
VP -1000,1000	*Move CD*
CR 500,90,180	*Move DE*
VP 0,0	*Move EA*
VE	*Indicate end of path*
BGS	*Start motion sequence*
EN	*End program*



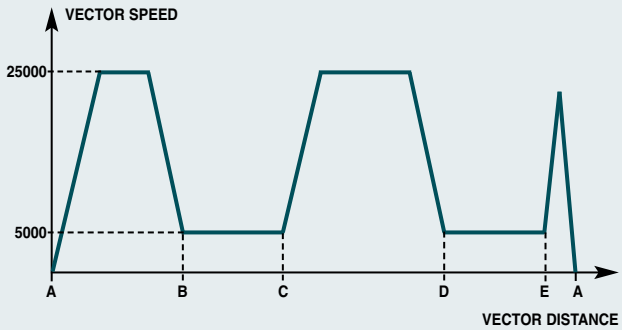
Another feature of the vector mode is tangential following that allows a third axis to remain tangent to the trajectory, which is ideal for cutting tools. Helical motion is also possible by commanding the third axis to follow the coordinated path at the same rate.

Example—Coordinated Motion with Maximum Feedrate

Repeat the previous example, but set the feedrate to the maximum values allowed. Due to accuracy requirements, the vector speed must be limited to 5000 counts/sec on the circular segments BC and DE. On the linear segment, the motor speed is limited to 25,000 counts/sec. This operation is simplified given the controller's ability to associate two speeds with each segment — upper and lower limits. These limits are designated by the < and > symbols.

The resulting motion will accelerate the motors to the maximum allowed speed, but will assure that the speed at the end of the segment is the one indicated by the > symbol. The resulting vector speed is shown as a function of the path in the figure below.

COMMAND	INTERPRETATION
#B	*Label*
CAS	*Set coordinate system*
VMXY	*Define XY plane*
VA 500000	*Acceleration*
VD 500000	*Deceleration*
VP 4000,0 <25000>5000	*Segment AB*
CR 500,-90,180	*Segment BC*
VP -1000,1000 <25000>5000	*Segment CD*
CR 500,90,180	*Segment DE*
VP 0,0 <25000	*Segment EA*
VE	*Specify end of path*
BGS	*Begin motion sequence*
EN	*End program*



General Description

Linear Interpolation (for controllers with two or more axes)

The linear interpolation mode (LM) allows any arbitrary path of up to 8 axes to be defined as a set of linear segments (LI). The vector speed (VS), vector acceleration (VA), vector deceleration (VD), and vector smoothing (VT) are also defined. Up to 511 LI segments can be given prior to the start of motion and additional segments can be sent during motion to allow paths of unlimited length to be followed.

Example—Linear Interpolation

Move a cartesian robot through the following points with the coordinates indicated in inches.

P0 (0,0,0)

P1 (4,2,1)

P2 (6,6,2)

P3 (8,8,0)

Assume that the resolutions of all the axes are 1000 counts/inch, and set the required speed to 1.2 inches/sec (1200 counts/sec) and the acceleration and deceleration to 100 in/sec^2 (100000 counts/sec^2). Note that the LM mode requires defining the segments in incremental form.

Point	Coordinate	Difference
P0	0,0,0	
P1	4000,2000,1000	4000,2000,1000
P2	6000,6000,2000	2000,4000,1000
P3	8000,8000,0	2000,2000,-2000

PROGRAM	INTERPRETATION
#C	*Label*
CAS	*Set coordinate system*
LM XYZ	*Define XYZ space*
VS 1200	*Vector speed*
VA 100000	*Vector acceleration*
VD 100000	*Vector deceleration*
LI 4000,2000,1000	*Segment P0-P1*
LI 2000,4000,1000	*Segment P1-P2*
LI 2000,2000,-2000	*Segment P2-P3*
LE	*End of move*
BGS	*Start the motion*
EN	*End program*

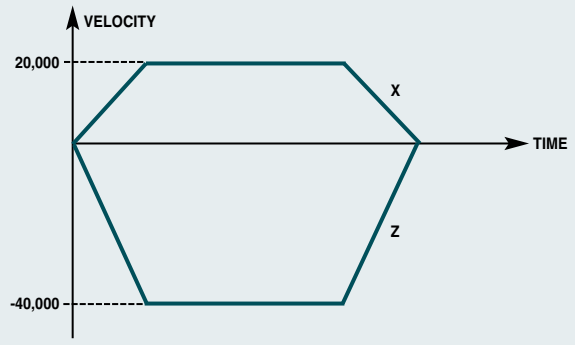
Electronic Gearing

The electronic gearing mode makes it easy for Galil controllers to simulate the motion of mechanical gears electronically. Any slave axis or set of slave axes can be geared to a master at a prescribed gear ratio defined by the (GR) command. The gear ratio can be changed on-the-fly and the controller permits multiple masters as defined by the (GA) command. A powerful feature of electronic gearing is that an axis can be geared and simultaneously be commanded to perform an independent or vector move. This is useful for the position correction required in packaging applications or when shapes must be cut on a moving conveyer belt. The electronic gearing mode is also useful for gantry applications where a special gantry mode (GM) command tightly couples two axes by ensuring that gearing cannot be disabled.

The gearing mode allows for a gradual ramp-to-gearing which results in smoother transitions when the gear ratio is changed. (GD) sets the distance of the master axis over which the slave will be engaged or changed to a new gear setting. The parameter (_GP) corrects for any accumulated errors in gearing during the ramp-to-gearing phase.

Example—Electronic Gearing

PROGRAM	INTERPRETATION
GA Y,,Y	*Specify Y axis as master of X and Z*
GR 2,,-4	*Specify gear ratios for X and Z*
PRY=50000	*Specify end position of master*
ACY=1000000	*Specify acceleration of master*
DCY=1000000	*Specify deceleration of master*
SPY=10000	*Specify slew speed of master*
BG Y	*Begin motion*



General Description

Contouring

The contouring mode (CM) is extremely flexible as it allows any arbitrary profile on any set of axes to be prescribed. Here, the user bypasses the controller profiler and directly inputs the position versus time trajectory. The trajectory is described as the position increment (CD) over a defined time period (DT). Additionally, the controller performs linear interpolation between prescribed points. The contour mode is useful for following complex, computer-generated paths or for "teaching" position paths. An automatic data-recording feature allows the controller to "learn" a path and then follow it in the contour mode.

Example—Contouring

Generate an XY motion according to a file of points specifying the position increments every 16 msec. To simplify the example, it is assumed that only 4 segments are required. An array is used for each axis.

Segment	DX	DY
1	40	40
2	100	20
3	80	-40
4	40	-20

PROGRAM	INTERPRETATION
#D	
DM DX[4],DY[4]	***Define arrays***
DX [0]=40;DY[0]=40	
DX [1]=100;DY[1]=20	
DX [2]=80;DY[2]=-40	
DX [3]=40;DY[3]=-20	
CM XY	***Specify contour***
DT4; P=0	***Time interval***
#LOOP	***Loop***
CD DX[P],DY[P]	***Specify contour data***
P=P+1	***Increment counter***
WC	***Wait to complete***
JP#LOOP, P<4	***Loop until done***
CD 0,0	***Contour data for end***
DT0	***Set time interval to 0 to end mode***
EN	***End program***

Electronic Cam

Any slave axis or set of slave axes can be linked to a master axis to simulate the motion of a mechanical Cam. Here, the master axis can be a motor-driven axis or a master encoder. The Cam functions are specified by a table that allows complex profiles with varying gear ratios to be prescribed. Any follower axis may be engaged or disengaged independently at specific points along a Cam cycle. This allows the user to select engagement and disengagement points where the speed change of the follower is minimal. The electronic Cam is an ideal mode for periodic operation, especially those requiring a varying gear ratio along the motion cycle. Applications include flying shears, rotating knives, and packaging systems. Galil's Cam-generating software can assist the user in defining the Cam table.

I/O

Error Handling

Dedicated I/O is provided for the following safety controls: forward and reverse limit inputs for each axis, home input for each axis, amplifier enable output for each axis, configurable abort inputs for each axis, master abort input, and error output. Also, the controller provides the following safety functions in software: upper and lower software travel limits, position error limits, and automatic shut-off on excess position error. Program interrupts are provided for error and limit conditions and run-time program errors. The program interrupts cause the program sequencer to automatically branch to an error handling subroutine. In order to provide flexibility and system protection, the error handling subroutine can be customized by the user.

User I/O

In addition to dedicated inputs for home and limits, Galil controllers provide user I/O for synchronizing motion with external events such as switches and relays. The DMC-18x0 controller, for example, includes 8 analog inputs, 8 digital inputs and 8 digital outputs for 1 to 4-axis models; and 8 analog inputs, 24 inputs and 16 outputs for 5–8 axis models. All Galil controllers include many commands for handling I/O such as input interrupts, I/O triggers and timers. The combination of user I/O and application programming often eliminates the need for a PLC.

As part of the user I/O, Galil controllers provide a high-speed position capture and position compare feature for each axis. The high-speed position capture latches the exact position within 0.1 microseconds (40 µsec with optoisolation) of the occurrence of an input. Position capture is crucial for applications requiring precise synchronization of position to external events such as coordinate measurement machines.

The high-speed position compare feature produces an output pulse at a precise position. The starting position for the initial pulse and incremental distance for subsequent pulses are programmable.

14204S006

Lo-Cog® DC Servo Motor

Assembly Data	Symbol	Units	Value	
Reference Voltage	E	V	24	
No-Load Speed	S_{NL}	rpm (rad/s)	3,702	(388)
Continuous Torque (Max.)[1]	T_C	oz-in (N-m)	26	(1.8E-01)
Peak Torque (Stall)[2]	T_{PK}	oz-in (N-m)	204	(1.4E+00)
Weight	W_M	oz (g)	38	(1083)
Motor Data				
Torque Constant	K_T	oz-in/A (N-m/A)	8.67	(6.12E-02)
Back-EMF Constant	K_E	V/krpm (V/rad/s)	6.41	(6.12E-02)
Resistance	R_T	Ω	1.01	
Inductance	L	mH	1.6	
No-Load Current	I_{NL}	A	0.26	
Peak Current (Stall)[2]	I_P	A	23.8	
Motor Constant	K_M	oz-in/√W (N-m/√W)	8.63	(6.09E-02)
Friction Torque	T_F	oz-in (N-m)	1.6	(1.1E-02)
Rotor Inertia	J_M	oz-in-s^2 (kg-m^2)	3.7E-03	(2.6E-05)
Electrical Time Constant	τ_E	ms	1.58	
Mechanical Time Constant	τ_M	ms	7.0	
Viscous Damping	D	oz-in/krpm (N-m-s)	0.18	(1.2E-05)
Damping Constant	K_D	oz-in/krpm (N-m-s)	55	(3.7E-03)
Maximum Winding Temperature	θ_{MAX}	ºF (ºC)	311	(155)
Thermal Impedance	R_{TH}	ºF/watt (ºC/watt)	45.9	(7.70)
Thermal Time Constant	τ_{TH}	min	28.8	
Gearbox Data				
Encoder Data				
Channels			3	
Resolution		CPR	500	

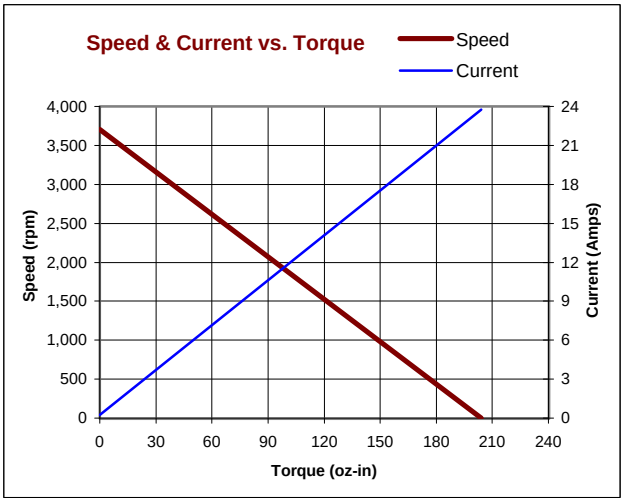
1 - Specified at max. winding temperature at 25ºC ambient without heat sink. 2 - Theoretical values supplied for reference only.

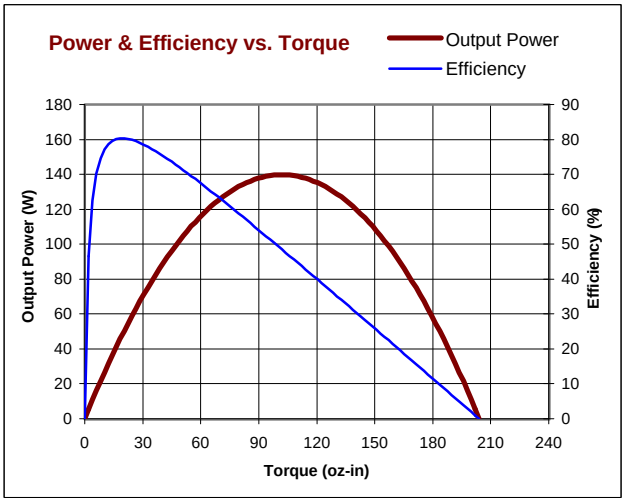
Included Features

2-Pole Stator
Ceramic Magnets
Heavy-Guage Steel Housing
11-Slot Armature
Silicon Steel Laminations
Stainless Steel Shaft
Copper-Graphite Brushes
Diamond Turned Commutator
Motor Ball Bearings

Customization Options

Alternate Winding
Sleeve or Ball Bearings
Modified Output Shaft
Custom Cable Assembly
Special Brushes
EMI/RFI Suppression
Spur or Planetary Gearbox
Special Lubricant
Optional Encoder
Fail-Safe Brake





All values are nominal. Specifications subject to change without notice. Graphs are shown for reference only.

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PITTMAN, 343 Godshall Drive, Harleysville, PA 19438, Phone: 877-PITTMAN, Fax: 215-256-1338, E-mail: info@pittmannet.com, Web Site: www.pittmannet.com

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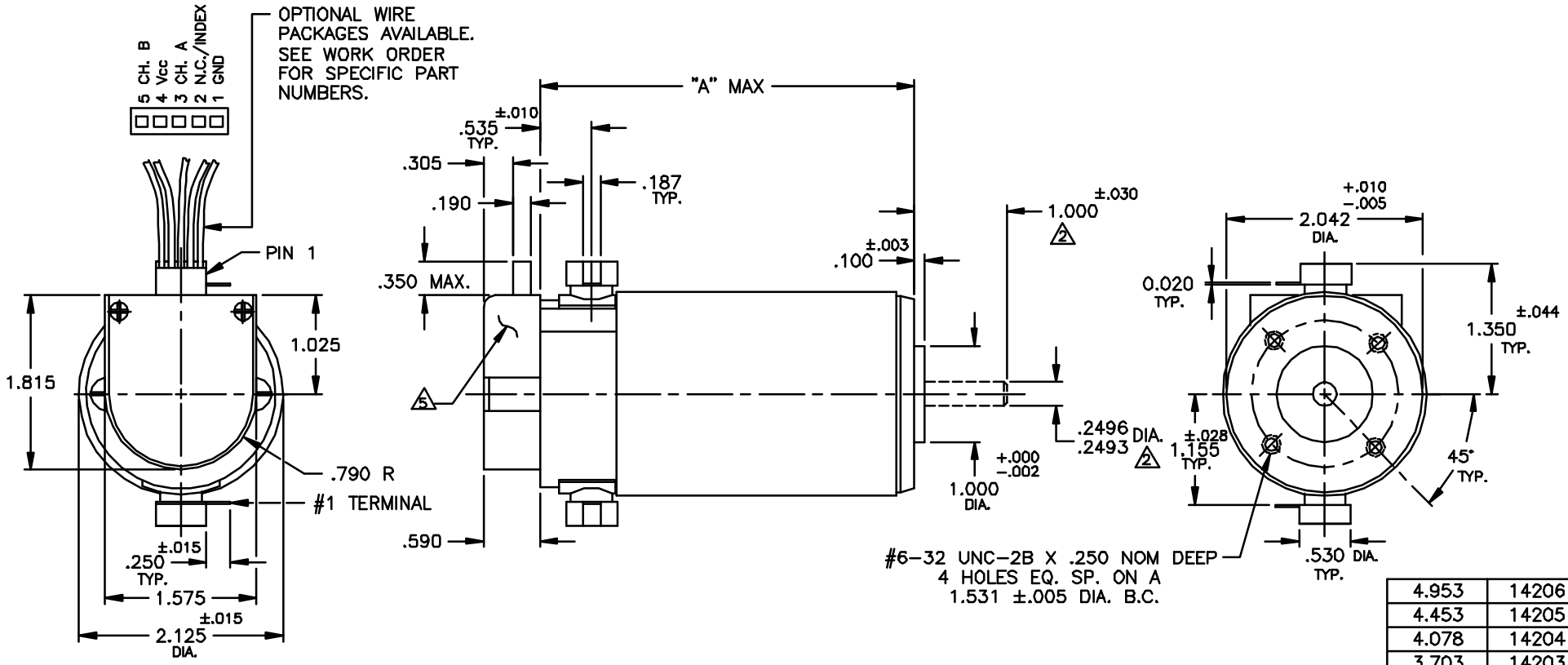
REVISIONS				
LTR	DESCRIPTION	DRFT/ENGR	DATE	APPR
E	REDRAWN, UPDATED TO CURRENT STDS.	KUH/KUH	9-13-95	JRM
F	REVISED ENDBELL DIMS & BRUSH HOLDER DIMS	TMG/DLF		



"A" MAX	MODEL NO.
4.953	14206
4.453	14205
4.078	14204
3.703	14203
3.203	14202
2.953	14201

NOTES:

1. SHAFT ROTATION IS CW WHILE VIEWING THE MOUNTING END, WITH POSITIVE VOLTAGE (+) APPLIED TO #1 TERMINAL.
2. ALL SHAFT DIMENSIONS NOTED ARE STANDARD (13-407-00□). FOR ALL OTHER SHAFT CONFIGURATIONS, REFER TO DATA SHEET FOR SHAFT PART NUMBERS.
3. BALL BEARINGS: PRELOAD PER P-107
4. MOLEX HOUSING 2695 SERIES WILL ACCEPT MOLEX MATING TERMINALS 2759.
5. ENCLOSED IS A H.P. HEDS-91X0 OPTICAL ENCODER MODULE.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTION ±1/64 DECIMAL .X ±.016 .XX ±.010 .XXX±.005 ANGLES ±1°
BREAK ALL SHARP EDGES

MATERIAL:

FINISH:

FILE: 150\229

DRAFTED BY	KUH	DATE 12 SEP 95
ENGINEERED BY	KUH	12 SEP 95
APPROVED BY	JR MELA	9-13-95

NEXT ASSY:

USED ON.

PITTMAN

TITLE: OUTLINE AND MOUNTING DIMS. 142XX W/ 91X0 ENCODER

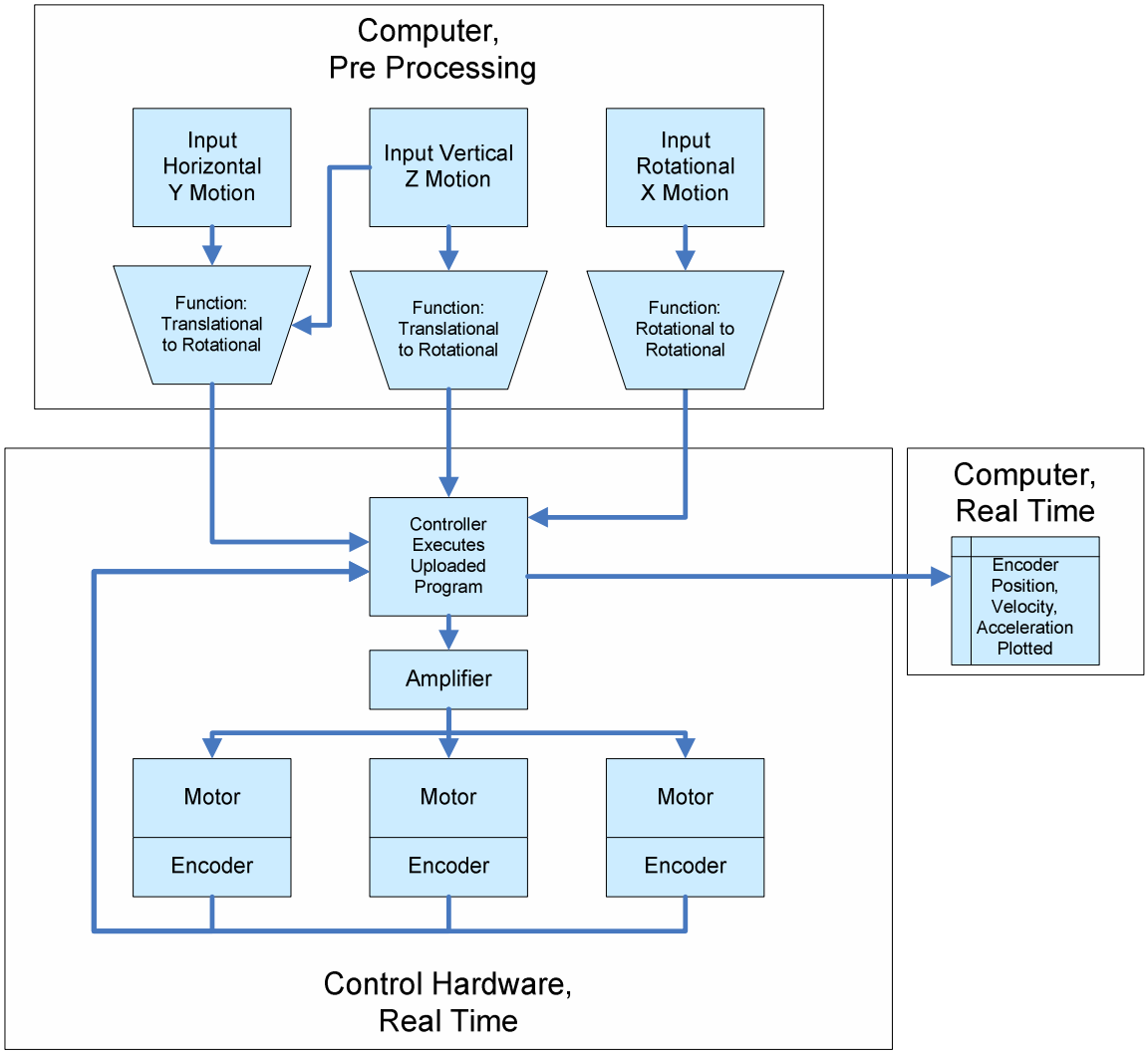
DWG. NO. B- 150-229 REV. F

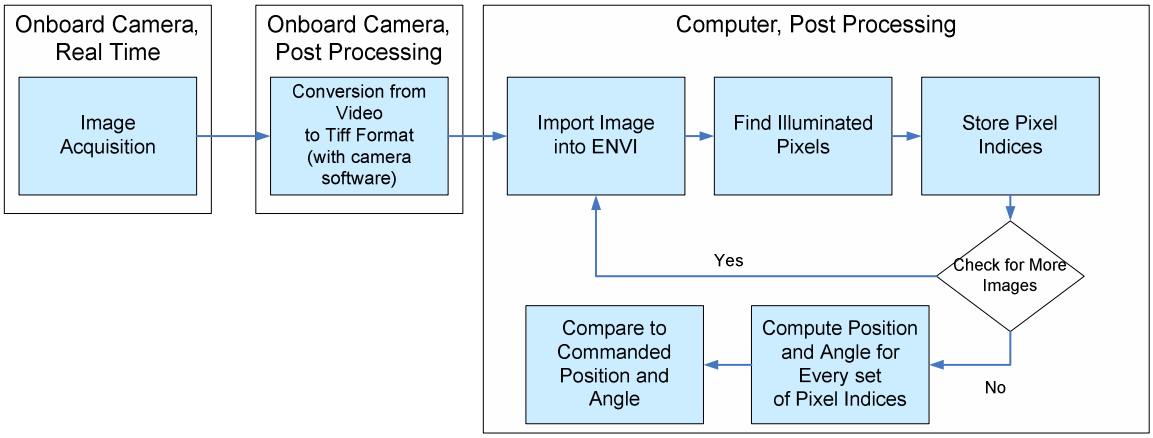
SCALE: NONE SHEET 1

BIRDIE Software Data Package

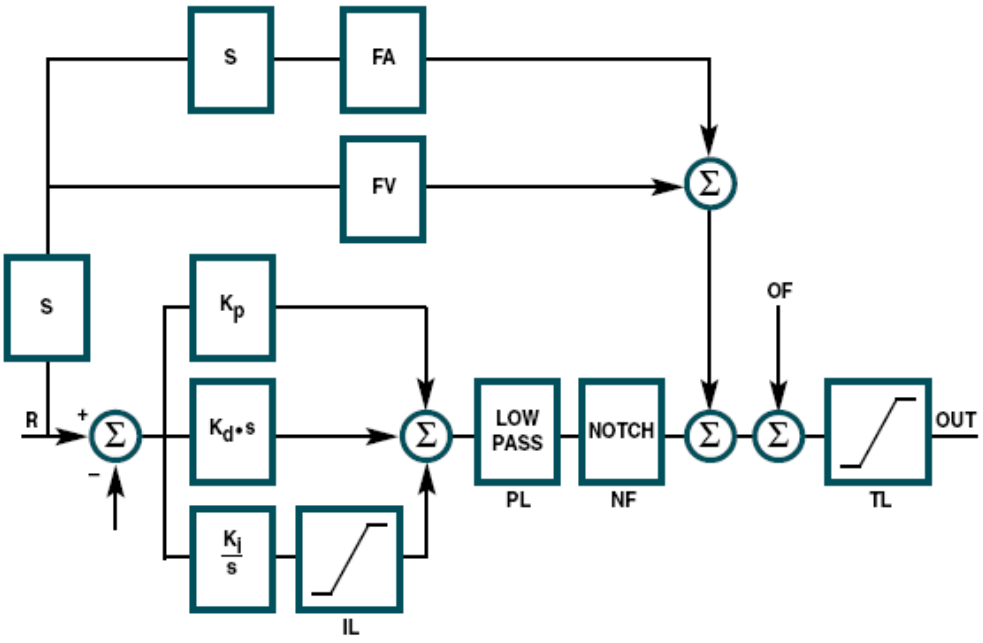
A-PDF MERGER DEMO

BIRDIE Software Tree										
Software Number	**Software Name**				**Input**	**Output**	**Manufacturer**	**Notes**	**Unit Cost**	**Total Cost**
01-000	Wing Motion, Controller									
01-001		Function, Trans to Rotate			Translational Position	Rotational Position	BIRDIE	Labview	Free	$0.00
01-002		Function, Rotate to Rotate			Rotational Position	Rotational Position	BIRDIE	Labview	Free	$0.00
01-003		Function, Rotational to Voltage			Rotate Position	Voltage to Amplifier	Galil		Free	$0.00
01-004		Function, Encoder Feedback			Error from desired	Correction to Orig Input	Galil		Free	$0.00
01-005		DMCWIN					Galil	Controller Drivers	Free	$0.00
					3					
02-000	Tip Verification,				1					
02-001		Function, Pic to Position			Picture	Location of Tip		IDL	Free	$0.00
02-002		Function, Position to Path			Position	Complete Path		IDL	Free	$0.00
					1					
					1					
										$0.00


Computer,
Pre Processing
Input Horizontal Y Motion
Input Vertical Z Motion
Input Rotational X Motion
Function: Translational to Rotational
Function: Translational to Rotational
Function: Rotational to Rotational
Controller Executes Uploaded Program
Amplifier
Motor
Encoder
Motor
Encoder
Motor
Encoder
Control Hardware,
Real Time
Computer,
Real Time
Encoder Position, Velocity, Acceleration Plotted


Onboard Camera, Real Time
Image Acquisition
Onboard Camera, Post Processing
Conversion from Video to Tiff Format (with camera software)
Computer, Post Processing
Import Image into ENVI
Find Illuminated Pixels
Store Pixel Indices
Check for More Images
Yes
No
Compute Position and Angle for Every set of Pixel Indices
Compare to Commanded Position and Angle

PID Block Diagram



Galil Utilities

SmartTERM, DMCSetup, MotorSizer™, CToolkit, API Toolkit

Galil Utilities

All Galil software programs can be downloaded from the Galil website or accessed from the CD-ROM. All necessary device drivers and DLL's are included for current Windows operating systems.

SmartTERM — Terminal program for sending commands, downloading and editing programs, and updating flash firmware. Also includes **DMCNet**, an Ethernet utility for detecting and addressing Ethernet controllers.

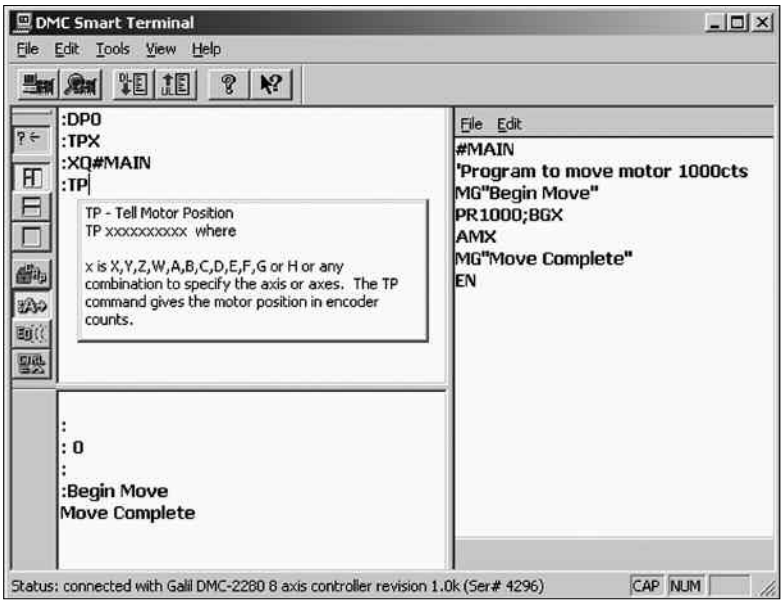
DMCSetup — Utility to upload, download, view, and save burned parameters to disk.

DMCDOS — Utility programs and example source code for communicating in the DOS environment.

DMCQNX — QNX utilities

DMCLNX — Linux Terminal with PCI, and Ethernet drivers.

SmartTERM



DMCSETUP

Galil's set-up software is for easily displaying and editing the configuration parameters of Galil controllers. You can see the contents of the controller registers "at a glance."

You can view motor type, filter parameters, default settings, switch status, etc. To change a parameter, you merely "click" on that parameter with the mouse and enter a new value. This makes setting up the controller a snap.

The software tool also lets you save (and load) parameters to (and from) a file. This is useful prior to master resets or changing firmware. The software also has a terminal and on-line help. This software is included on the Galil software CD.

Web-based MotorSizer™ Tool

Galil's MotorSizer is a free, web-based tool for easy sizing of your motion system. This easy-to-use tool lets you specify your load and motion requirements for various mechanical systems. MotorSizer performs a thorough analysis to select motors and amplifiers (or enter your own) that can drive your load to the motion requirements. Galil's MotorSizer tool analyzes both stepper and servo motor systems. MotorSizer is password protected (registration is required) and automatically saves your data for future reference.

Access MotorSizer at: http://www.galilmc.com/support/motorsizer/index.html.

C/C++ Programmers Toolkit

Galil's C/C++ Programmers Tool Kit includes DMCWIN software that provides C libraries (Linux, DOS and QNX versions are also available), sample programs, utilities, a complete terminal program, and full documentation. With this kit, all Galil motion controllers can be programmed using standard C/C++ compilers including Borland, Microsoft, Watcom and others. The kit is also compatible with Galil ActiveX Tool Kit.

Partial DLL API list:

The following represents a partial list from over 60 API functions.

DMCOpen	Open communications
DMCClose	Close communications
DMCCommand	Send a command
DMCBinaryCommand	Send binary command
DMCDownloadFile	Download a file from hard disk
DMCArrayUpload	Upload an array

DMC.NET API Toolkit

Galil has taken its 'C' Application Programming Interface (API) and ported it to .NET (Framework v1.1). This object oriented API uses .NET native types to provide a communication interface to Galil Motion Controllers. It can be used from any of the VisualStudio.NET managed languages (VB, C++, C#, J#).

The DMC .NET API includes objects for basic communications, data record access, array operations, and Galil registry modifications. Exception based error handling as well as many other forms of the traditional function calls are implemented to make the API very versatile and help reduce programming. Dynamic help files and sample code are also included. Users of the older 'C' API should find the new .NET version familiar and that it fits more naturally into the .NET environment.

In .NET, the Galil .NET API objects can be imported to your project by simply adding a reference to the **DMCdNet.dll** class library. The simple VB.NET example below shows how the DMCAPI object is used to send "TPX" to the controller and display the response in a text box.

Example C Program tells the controller to move the X-axis motor 1000 counts.

```
#include <windows.h>
#include <Dmccom.h>

long rc;
HANDLEDMC hDmc;
char szBuffer [64];

int main(void)
{
        rc = DMCOpen(1,0,&hDmc);
        rc = DMCCommand(hDmc,"PR1000;BGX;",szBuffer,
sizeof(szBuffer));
        rc = DMCClose(hDmc);
        return 0;
}
```

DMC.NET API Toolkit

```
Imports Galil 'use Galil namespace

Public Class Form1
    Inherits System.Windows.Forms.Form
    'declare controller object
    Dim Controller As DMCAPI

+Windows Form Designer generated code

    Private Sub Form1_Load(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles MyBase.Load

        'allocate memory for controller object
        Controller = New DMCAPI
        'open communications
        Controller.apiOpen(1, System.IntPtr.Zero)
        'declare response string
        Dim sResponse As String
        'send command to controller
        Controller.apiCommand("TPX", sResponse)
        'display response
        TextBox1.Text = "X position: " + sResponse

    End Sub

    Private Sub Form1_Closed(ByVal sender As Object, _
    ByVal e As System.EventArgs) Handles MyBase.Closed

        'close communications
        Controller.apiClose()

    End Sub
End Class
```

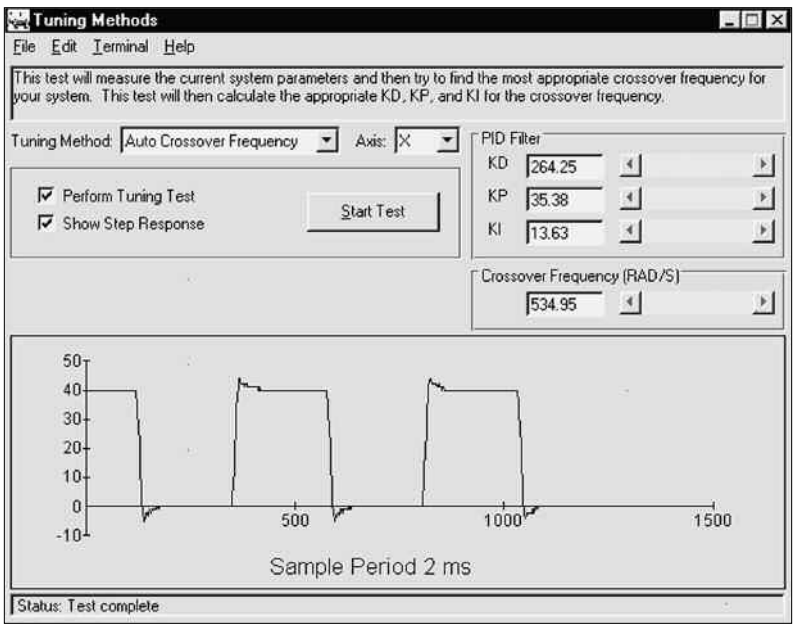
Servo Tuning Software

WSDK

Product Description

The WSDK (Windows Servo Design Kit) allows easy system setup, tuning, and evaluation. This powerful software package is recommended for all first time users of Galil controllers. WSDK software provides automatic PID tuning for optimizing performance. Several tuning methods are provided allowing automatic tuning for a wide variety of systems and loads.

A four-channel storage scope provides a display of the actual position, velocity, error, and torque. The WSDK software also provides several tests for design and analysis of servo systems. These tests include impulse, step and frequency response.



WSDK's automatic tuning routines set the best PID values and display the step response of the system.

Features

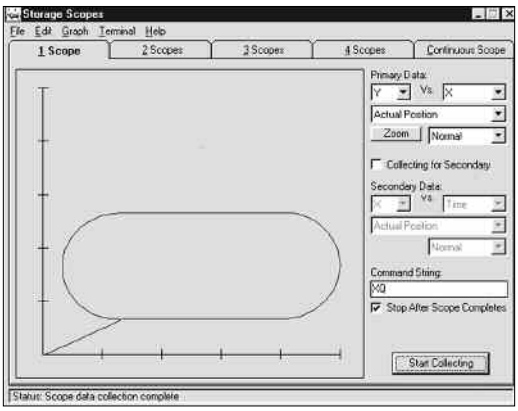
- *Allows easy setup, tuning, and analysis of motion systems*
- *Menu-driven, no programming experience required*
- *Four-channel storage scope for displaying real-time position, velocity, error, and torque*
- *Displays X versus Y position for viewing actual 2-D motion path*
- *Terminal emulator and program editor for easy communication with the motion controller*
- *Automatic tuning procedures for quick and easy selection of controller's PID parameters—optimizes performance of actual system hardware*
- *Provides impulse, step, and frequency response tests on actual hardware*
- *Displays system parameters and motion status in convenient matrix format*

System Requirements

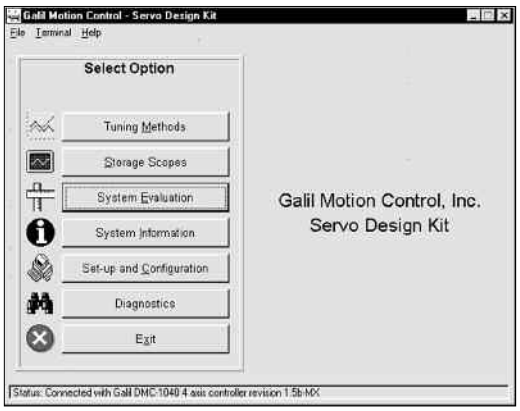
- 16MB RAM, 25MB disk space
- Galil controller installed
- Windows 98SE or newer

Servo Tuning Software

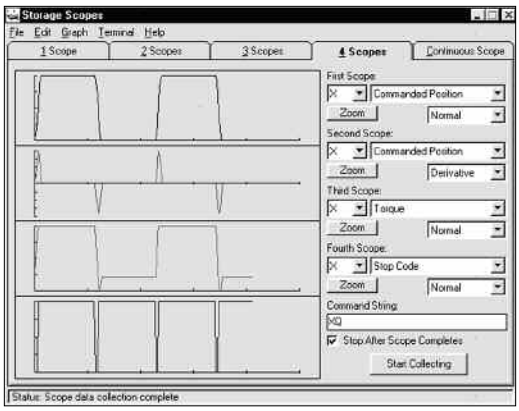
WSDK



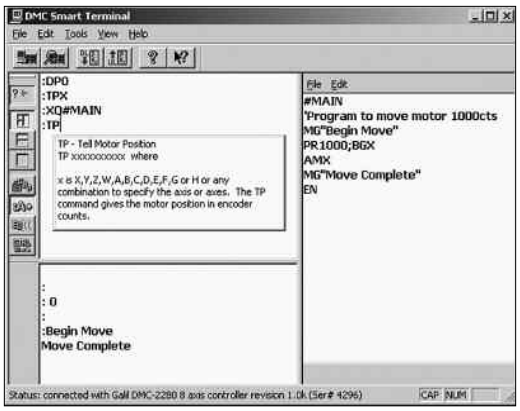
WSDK displays the X versus Y positions, allowing the 2-D motion path to be easily recorded.



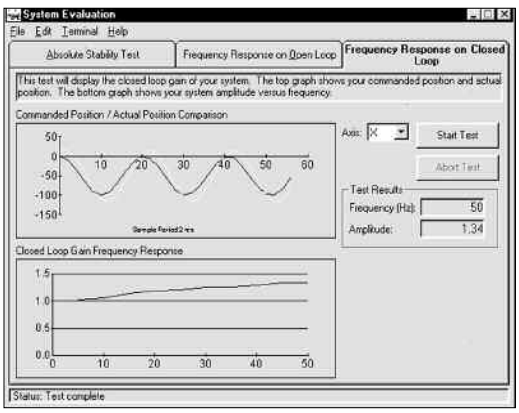
WSDK's main menu provides many options for system set-up.



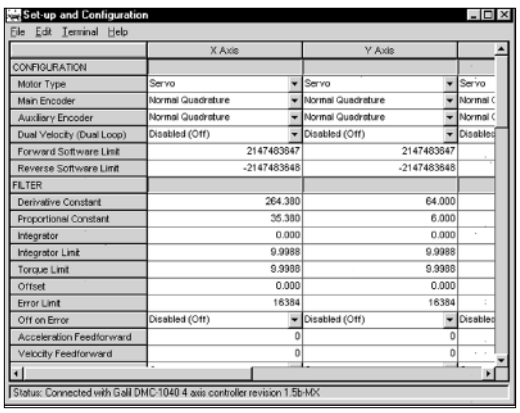
The multi-channel storage scope records up to four channels of information. Many types of data can be observed including actual and command position, velocity, error, torque, and I/O status.



A terminal emulator and editor allows programs to be easily entered.


System Evaluation
File Edit Terminal Help
Absolute Stability Test
Frequency Response on Open Loop
Frequency Response on Closed Loop
This test will display the closed loop gain of your system. The top graph shows your commanded position and actual position. The bottom graph shows your system amplitude versus frequency.
Commanded Position / Actual Position Comparison
Axis:
Start Test
Abort Test
Test Results
Frequency (Hz):
50
Amplitude:
1.34
Closed Loop Gain Frequency Response
Status: Test complete

The WSDK performs a closed-loop frequency response test on the actual hardware allowing the system bandwidth and any resonances to be observed.



System parameters are displayed in a convenient matrix format.

SOFTWARE

BIRDIE Mechanical Data Package

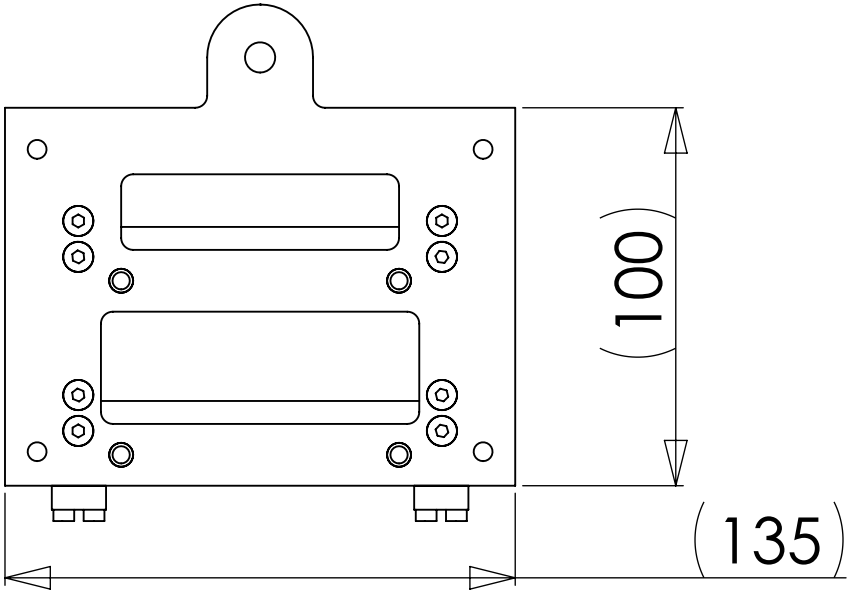
A-PDF MERGER DEMO

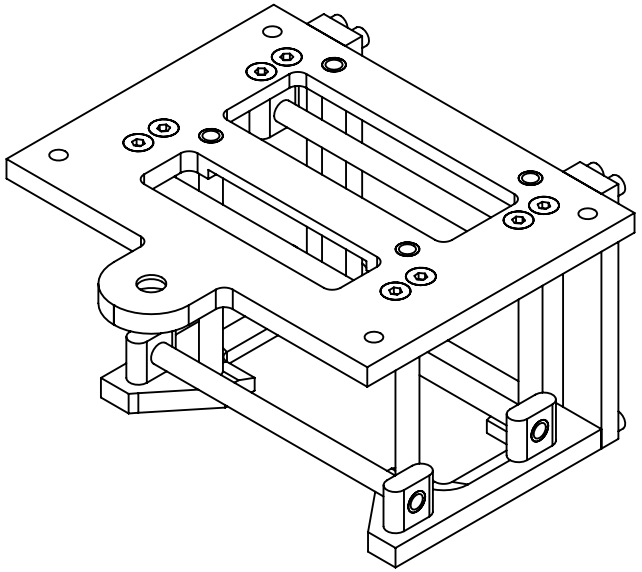
BIRDIE Drawing Tree

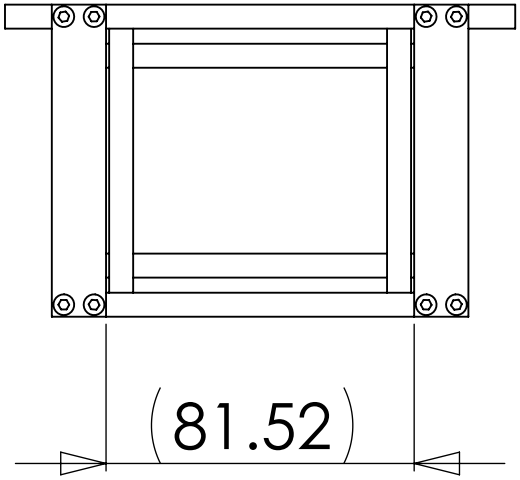
Drawing Number	Drawing Name	Dimensions	Material	Quantity	Make/ Buy	Vendor	Unit Cost	Total Cost
01-00-00	Assembly, Wing Mechanism			1				
01-01-00	Assembly, Bed							
	Bed, Screw, Bed			8	Buy	McGuckins	$0.40	$3.20
	Bed, Screws, CAG			16	Buy	McGuckins	$0.40	$6.40
01-01-01	Bed, Support, Back	6.35x14.35x82.58	Al 6061-T6	2	Make	Online Met	$0.70	$1.40
01-01-02	Bed, Support, Upper	6.35x127.32x135	Al 6061-T6	1	Make	Online Met	$9.91	$9.91
01-01-03	Bed, Support, Lower	6.35x77.05x110.2	Al 6061-T6	1	Make	Online Met	$4.99	$4.99
01-01-04	CAG, Bracket, Horizontal Guide	6.35x13.35x15.85	Al 6061-T6	8	Make	Online Met	$0.36	$2.88
01-01-07	CAG, Guide, Bracket, Horizontal	6.35(OD)x102.57	Al 6061-T6	4	Buy	Online Met	$1.25	$5.00
01-01-08	CAG, Guide, Bracket, Vertical	6.35(OD)x82.55m	Al 6061-T6	4	Buy	Online Met	$1.01	$4.04
01-02-00	Assembly, CAG, Horizontal Slide							$0.00
01-02-01	CAG, Bracket, Control Arm Guide	12.7x13.53x59.58	Al 6061-T6	2	Make	Online Met	$0.74	$1.48
01-02-02	CAG, Guide, Control Arm, Horizontal	6.35(OD)x87.05m	Al 6061-T6	2	Buy	Online Met	1.05	$2.10
01-02-03	CAG, Linear Bearing	.25x.375x.5 in	PTFE	4	Make	Small Parts	$0.45	$1.80
01-03-00	Assembly, CAG, Vertical Slide							$0.00
01-02-01	CAG, Bracket, Control Arm Guide	12.7x13.53x59.58	Al 6061-T6	2	Make	Online Met	$0.74	$1.48
01-03-01	CAG, Guide, Control Arm, Vertical	6.35(OD)x69.05m	Al 6061-T6	2	Buy	Online Met	$0.90	$1.80
01-02-03	CAG, Linear Bearing	.25x.375x.5 in	PTFE	4	Make	Small Parts	$0.45	$1.80
01-04-00	Assembly, Control Arm, Inner							$0.00
01-04-01	Control Arm, Inner	5x10x36.84mm	Al 7075-T6	1	Make	Online Met	$0.85	$0.85
01-04-02	Control Arm, Pin	2x16 mm	303 Stainless Steel	1	Buy	W.M Berg	$0.94	$0.94
01-05-00	Assembly, Control Arm, Outer							$0.00
01-02-03	CAG, Linear Bearing	.25x.375x.5 in	PTFE	4	Make	Small Parts	$0.45	$1.80
01-05-01	Control Arm, Linear Bearing	.25x.375x1.25 in	PTFE	1	Make	Small Parts	1.2	$1.20
01-05-02	Control Arm, Outer	12.7(OD)x74.732	Al 7075-T6	1	Make	Online Met	1.3	$1.30
01-06-00	Assembly, Gimbal y							$0.00
01-06-01	Gimbal, Gimbal y	13x15x22.2mm	Al 6061-T6	1	Make	Online Met	$0.90	$0.90
01-06-02	Gimbal, Gimbal y, Washer	9.53(OD)x0.6mm	Delrin	2	Buy	McGuckin	$0.17	$0.34
01-06-03	Gimbal, Rotary Bearing	6x10x3 mm		4	Buy	VXB	0.99	$3.96
01-08-01	Joint, Inner	3.18(OD)x4mm	Brass C260	1	Buy	Small Parts	0.75	$0.75
01-08-02	Joint, Pin	2x10 mm	303 Stainless Steel	1	Buy	W.M. Berg	0.73	$0.73
01-08-03	Joint, Washer	3.18(OD)x0.3mm	Brass	2	Buy	McGuckin	0.14	$0.28
01-07-00	Assembly, Gimbal z							$0.00

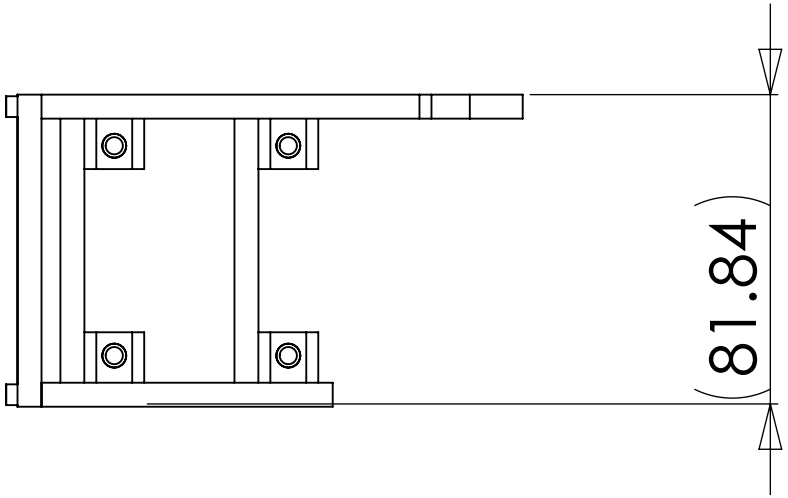
01-07-01			Gimbal, Gimbal z, Bearing	7x14x5 mm		1	Buy	VXB	4.95	$4.95
01-07-02			Gimbal, Gimbal z, Screw, Side			4	Buy	McGuckin	0.4	$1.60
01-07-03			Gimbal, Gimbal z, Screw, Slide			8	Buy	McGuckin	0.4	$3.20
01-07-04			Gimbal, Gimbal z, Side	3x10x43.34mm	Al 6061-T6	2	Make	Online Met	0.12	$0.24
01-07-05			Gimbal, Gimbal z, String Slide, Side	9.525(OD)x18mm	PTFE	2	Make	Small Parts	1.2	$2.40
01-07-06			Gimbal, Gimbal z, String Slide, Top	6.35(OD)x12.6mm	PTFE	2	Make	Small Parts	0.45	$0.90
01-07-07			Gimbal, Gimbal z, Top	12.95x16.2x18mm	Al 6061-T6	1	Make	Online Met	1.08	$1.08
01-07-08			Gimbal, gimbal z, Washer	id = 7, t = .6 mm	Delrin	1	Buy	Mcmaster	0.17	$0.17
01-08-00		Assembly, Joint, Y Joint								$0.00
01-08-01			Joint, Inner	3.18(OD)x4mm	Brass C260	1	Buy	Small Parts	0.75	$0.75
01-08-02			Joint, Pin	2x10 mm	303 Stainless Steel	1	Buy	W.M. Berg	0.73	$0.73
01-08-03			Joint, Washer	3.18(OD)x0.3mm	Brass	2	Buy	McMaster	0.14	$0.28
01-08-04			Joint, Y	5x10x13.15mm	Al 7075-T6	1	Make	Online Met	0.5	$0.50
01-09-00		Assembly, WLM								$0.00
01-09-01			WLM, Collet			1	Buy	McGuckins	$2.58	$2.58
01-09-02			WLM, Collet Nut	12.5(OD)x11.29mm		1	Buy	McGuckins	$2.25	$2.25
01-09-03			WLM, Rotary Arm	9.6(OD)x18.06mm	4340 Steel	1	Make	Online Met	$0.47	$0.47
02-00-00	Assembly, Test Bed									$0.00
02-01-00		Assembly, Support Beam								$0.00
02-01-01			Support Beam, Arm, Horizontal	6.35x15x83mm	Al 6061-T6	2	Make	Online Met	0.72	$1.44
02-01-02			Support Beam, Arm, Vertical, Lower	6.35x15x102.5mm	Al 6061-T6	1	Make	Online Met	0.86	$0.86
02-01-03			Support Beam, Arm, Vertical, Upper	6.35x15x80.45mm	Al 6061-T6	1	Make	Online Met	0.69	$0.69
02-01-04			Support Beam, Nut	4x12x13.86mm		8	Buy	McGuckins	0.35	$2.80
02-01-05			Support Beam, Pin	2.5x14 mm	303 Stainless Steel	4	Buy	W.M. Berg	1.4	$5.60
02-01-06			Support Beam, Roller	12.7(OD)x6.35mm	PTFE	4	Make	Small Parts	0.7	$2.80
02-01-07			Support Beam, Screw			8	Buy	McGuckins	0.4	$3.20
02-01-08			Support Beam, Set Screw	#6, 3/16in		3	Buy	McGuckins	0.16	$0.48
02-01-09			Support Beam, String Pulley	27.05(OD)x19.05	Al 7075-T6	3	Make	Online Met	1.96	$5.88
02-01-10			Support Beam, Support Beam	50.8x6.35x500mm	Hot Roll Steel	1	Make	Online Met	20.33	$20.33
02-02-00		Assembly, Test Structure								
			Base-Support	152.4x101.6x88.9	Steel	4	Buy	Unistrut		$0.00
			Bolt	6x6x22mm	Steel	80	Buy	Unistrut		$0.00
			Bottom Corner Fitting	32.13x32.13x305	Steel	4	Buy	Unistrut		$0.00
02-02-01			Casing, Casing	3.175x1000x100	Polycarbonate	6	Buy	Profession	51.75	$310.50
			Casing, Elevator Bolt	1/4"(OD)x3/4"	Steel	50	Buy	McMaster-	$0.21	$10.50
			Casing, Self Locking Retaining Ring	0.042"x0.25"(ID)x	Steel	100	Buy	McMaster-	$0.04	$4.00
			Casing, Wing Nut	37/64"x9/8"(OD)	Zinc Alloy	50	Buy	McMaster-	$0.27	$13.50

			Channeling		32.13x32.13x305	Steel	68	Buy	Unistrut		$0.00
			Mid-Section Roller		79.4x31.8x43.7m	Steel	4	Buy	Unistrut		$0.00
			Mid Side Fitting		232.6x95.3x98.4r	Steel	4	Buy	Unistrut		$0.00
			Nut		32.13x32.13x32.1	Steel	80	Buy	Unistrut		$0.00
			Upper Corner Fitting		98.4x95.3x41mm	Steel	4	Buy	Unistrut		$0.00
02-03-00		Assembly, Tip Maker									
02-03-01			Tip Marker, Template		1"x4"x5"	Al 6061-T6	1	Make	Online Met	$27.40	$27.40
			Tip Marker, Paint 1		1 Oz.	Strontium	1	Buy	SHANNON	$12.00	$12.00
			Tip Marker, Paint 2		1 Oz.	Strontium	1	Buy	SHANNON	$12.00	$12.00
										Total	$517.41
						Parts to buy	543				
						Parts to make	51				
						Total Parts	600				









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NEXT ASSY	USED ON
APPLICATION	

Tolerance (mm): .127

MATERIAL: As Made

FINISH: --

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

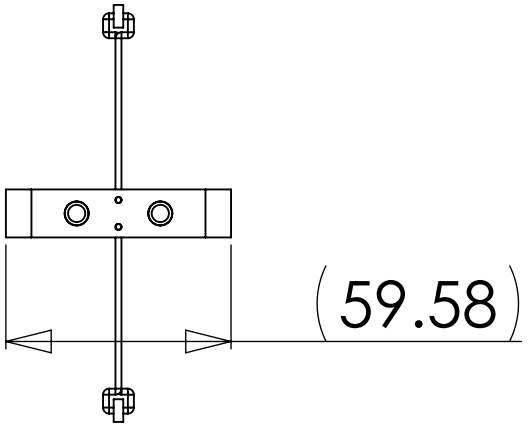
COMMENTS:

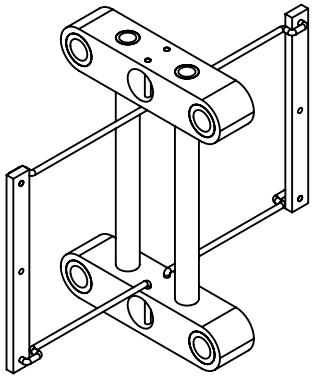
BIRDIE

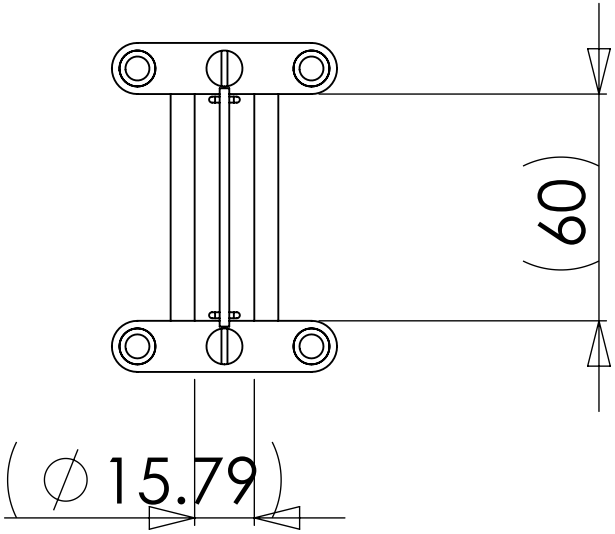
Assembly, Bed

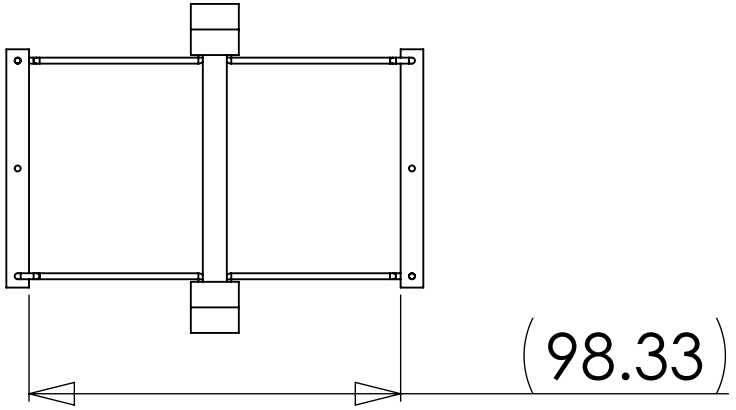
SIZE A | DWG. NO: 01-01-00 | REV.

WEIGHT: | SHEET 1 OF 1









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NEXT ASSY	USED ON
APPLICATION	

MATERIAL: As Made
FINISH: --
DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

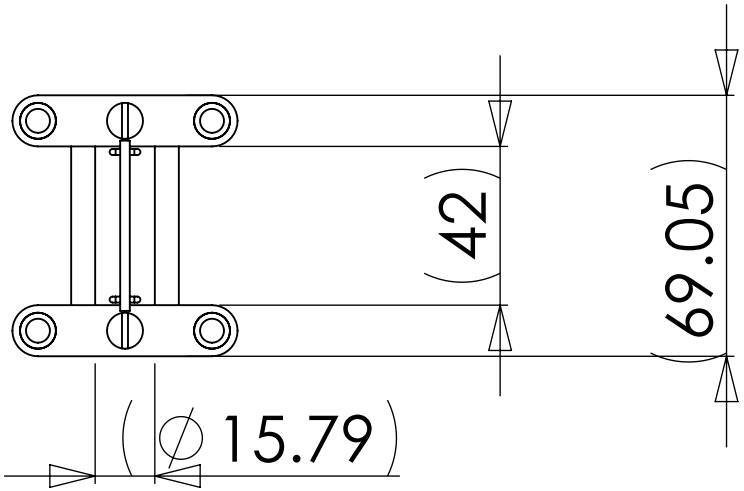
COMMENTS:

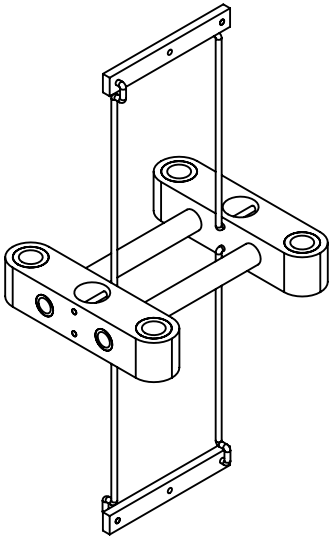
BIRDIE

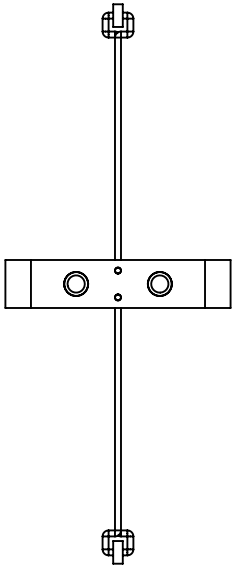
Assembly, CAG, Horizontal Slide

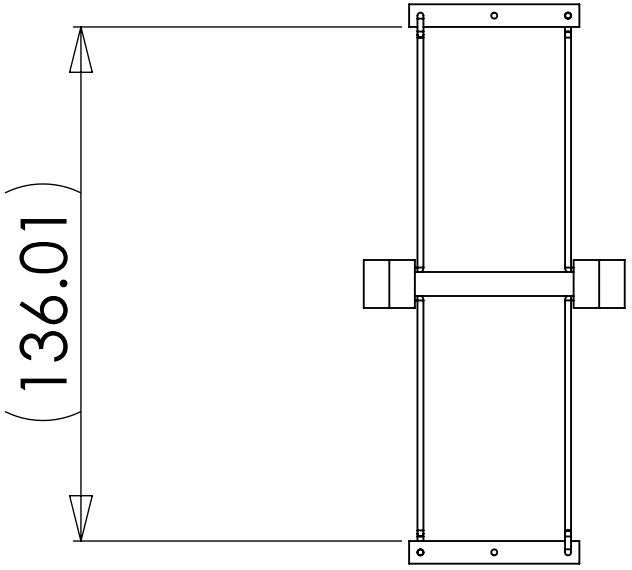
SIZE A | DWG. NO: 01-02-00 | REV.

WEIGHT: | SHEET 1 OF 1









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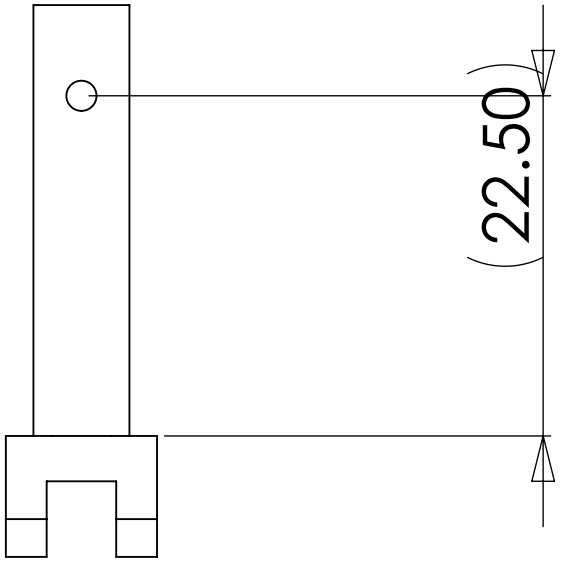
			NAME	DATE
		DRAWN		
		CHECKED		
		ENG APPR.		
		MFG APPR.		
		Q.A.		
		COMMENTS:		
NEXT ASSY	USED ON			
APPLICATION		DO NOT SCALE DRAWING		

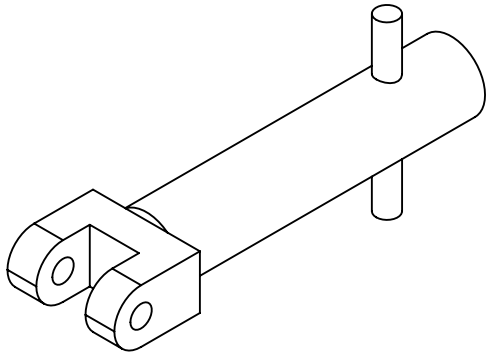
MATERIAL: As Made
FINISH: --

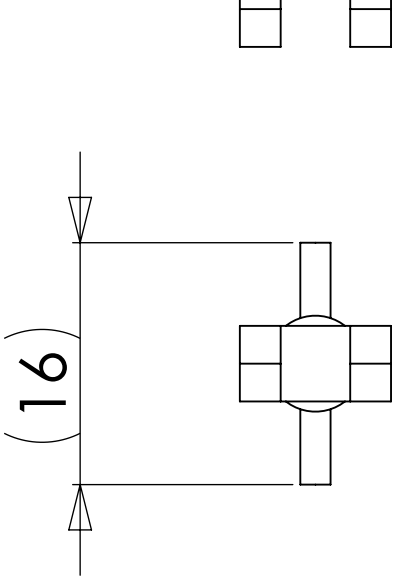
BIRDIE

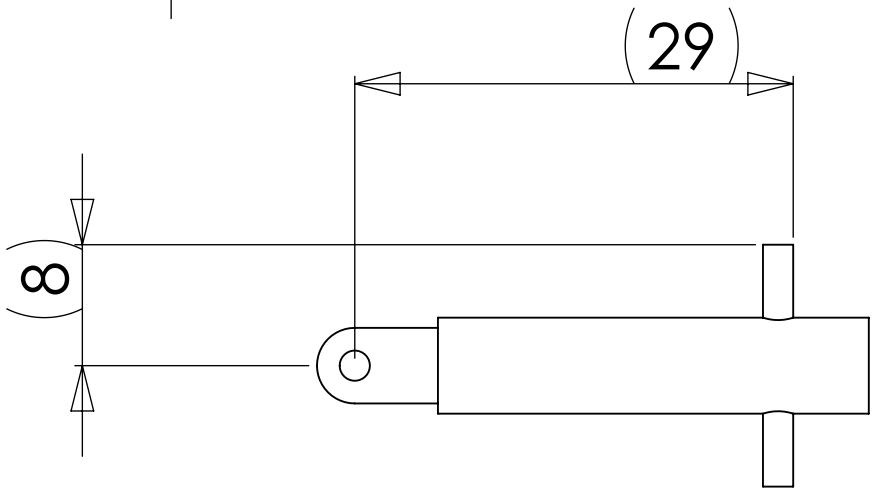
Assembly, CAG, Vertical Slide

SIZE A | DWG. NO: 01-03-00 | REV.
WEIGHT: | SHEET 1 OF 1









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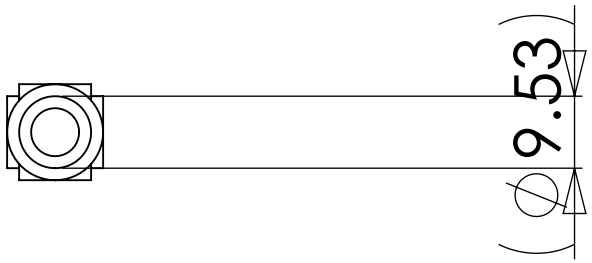
Tolerance (mm): .127	
MATERIAL	Al 7075-T6
FINISH	--
NEXT ASSY	USED ON
APPLICATION	DO NOT SCALE DRAWING

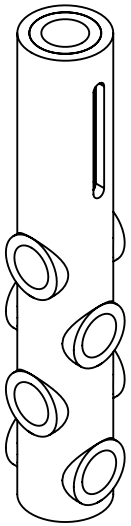
	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		
COMMENTS:		

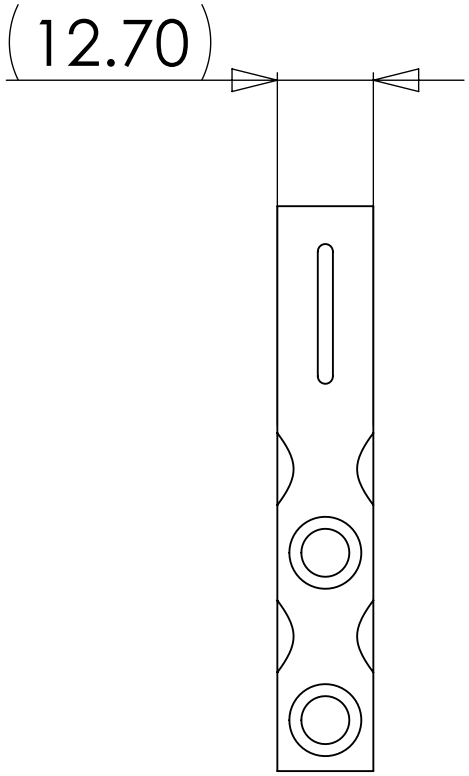
BIRDIE

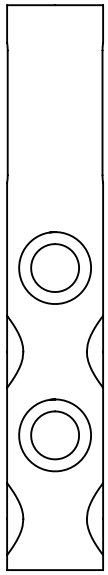
Assembly, Control Arm, Inner

SIZE	DWG. NO:	REV.
A	01-04-01	
	WEIGHT:	SHEET 1 OF 1









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NEXT ASSY	USED ON
APPLICATION	

Tolerance (mm): .127

MATERIAL: As Made

FINISH: --

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

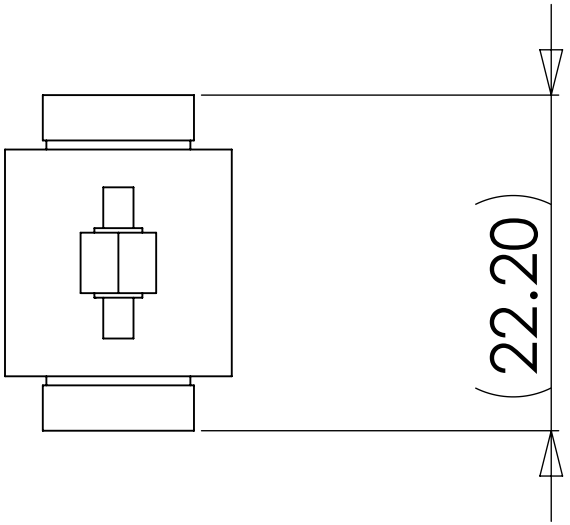
COMMENTS:

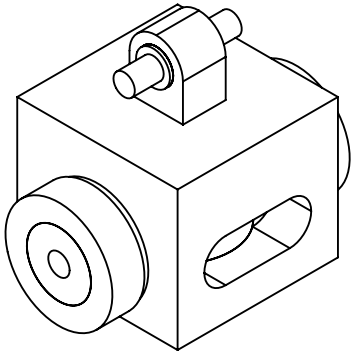
BIRDIE

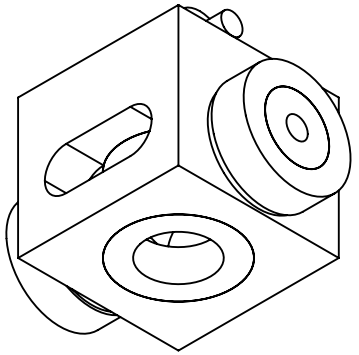
Assembly, Control Arm, Outer

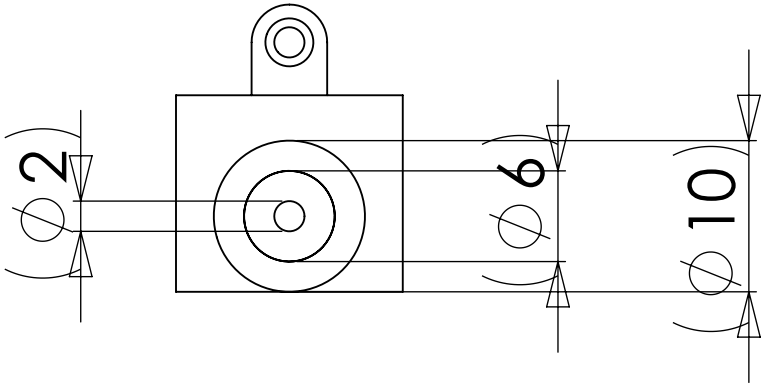
SIZE A | DWG. NO: 01-05-00 | REV.

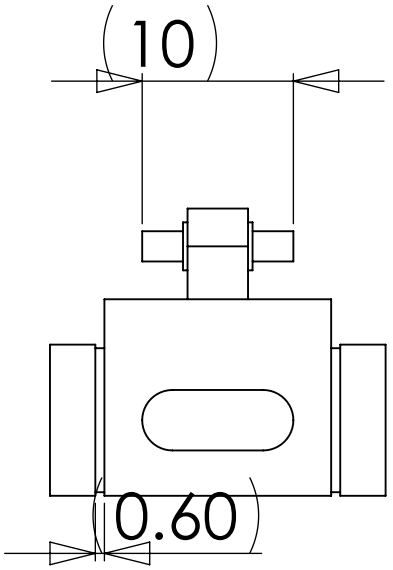
WEIGHT: | SHEET 1 OF 1











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NEXT ASSY	USED ON
APPLICATION	

Tolerance (mm): .127

MATERIAL: As Made

FINISH: --

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

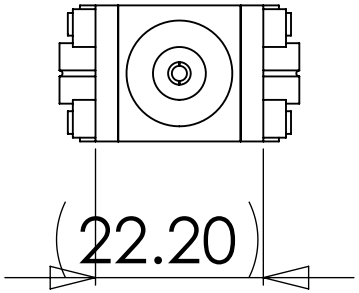
COMMENTS:

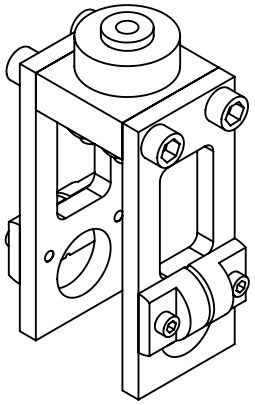
BIRDIE

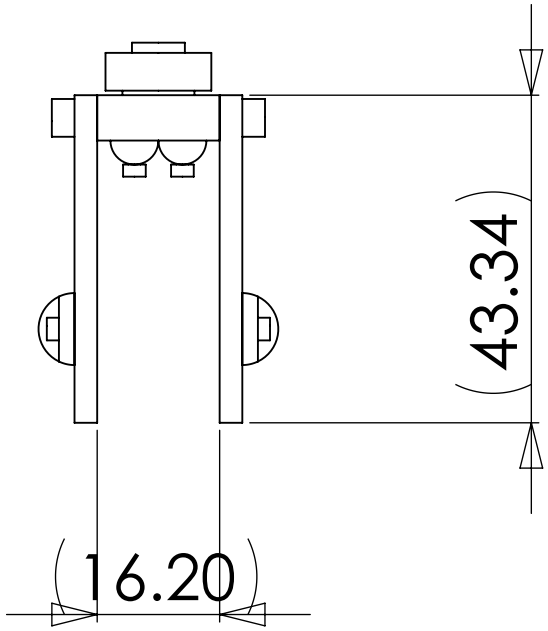
Assembly, Gimbal, y

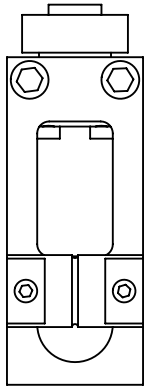
SIZE A | DWG. NO: 01-06-00 | REV.

WEIGHT: | SHEET 1 OF 1









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NEXT ASSY	USED ON
APPLICATION	

Tolerance (mm): .127

MATERIAL As Made

FINISH --

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

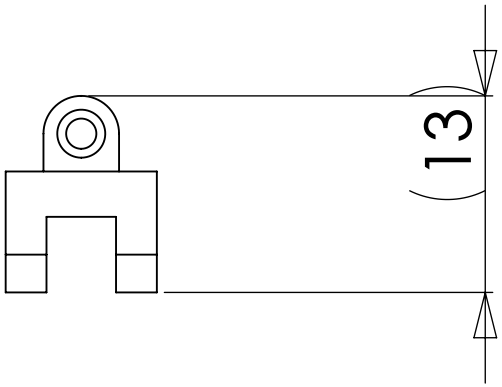
COMMENTS:

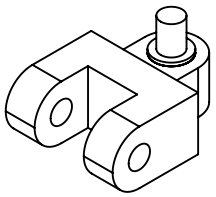
BIRDIE

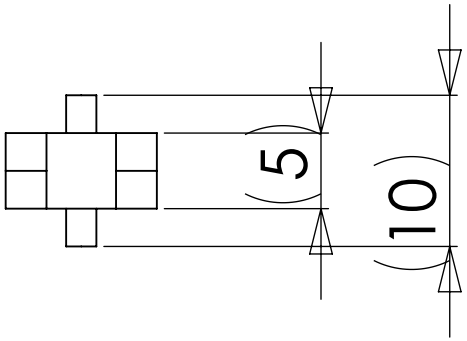
Assembly, Gimbal z

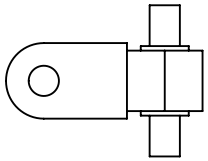
SIZE A | DWG. NO: 01-07-00 | REV.

WEIGHT: | SHEET 1 OF 1









PROPRIETARY AND CONFIDENTIAL
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REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF BIRDIE IS PROHIBITED.

NEXT ASSY	USED ON
APPLICATION	

Tolerance (mm): .127

MATERIAL As Made

FINISH --

DO NOT SCALE DRAWING

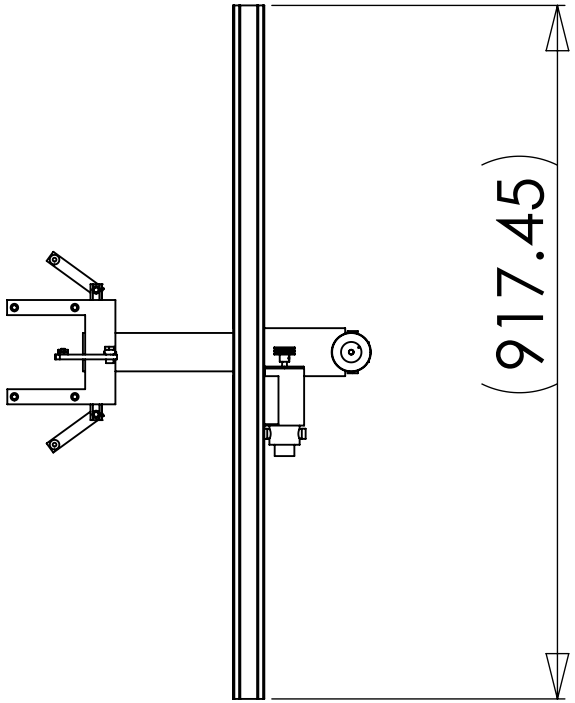
	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

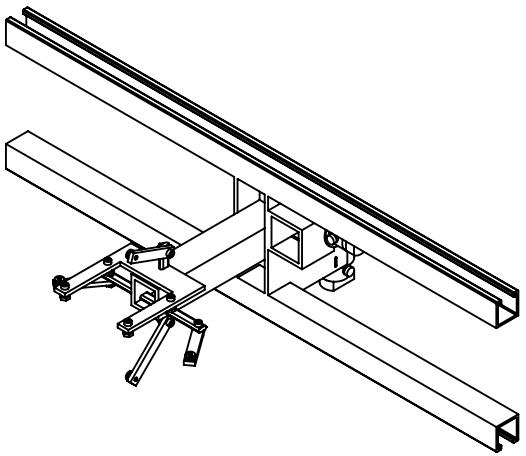
COMMENTS:

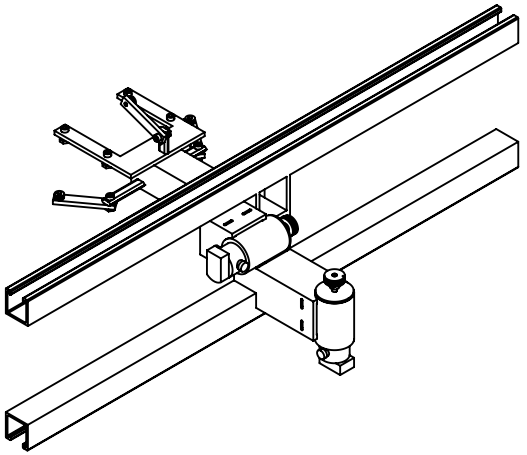
BIRDIE

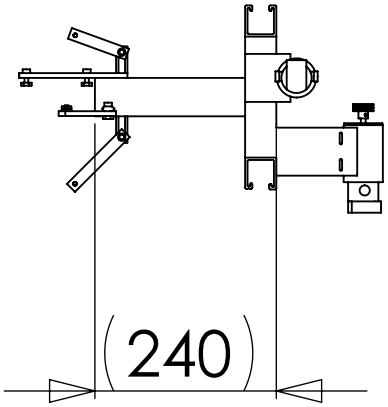
Assembly, Joint, Y Joint

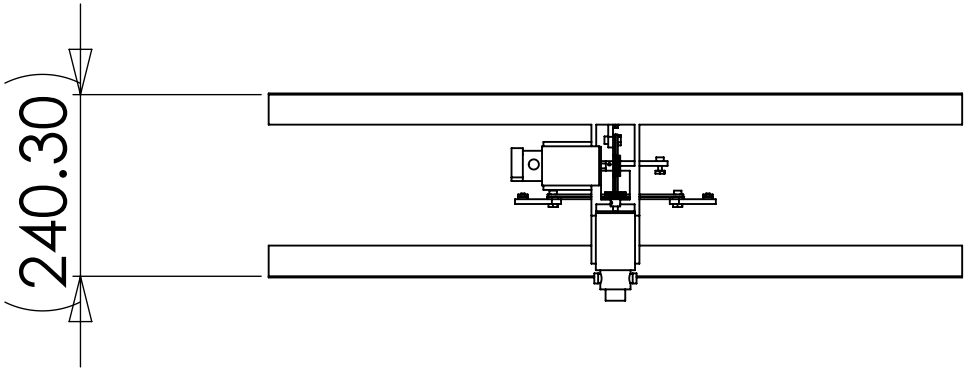
SIZE	DWG. NO:	REV.
A	01-08-00	
	WEIGHT:	SHEET 1 OF 1











PROPRIETARY AND CONFIDENTIAL
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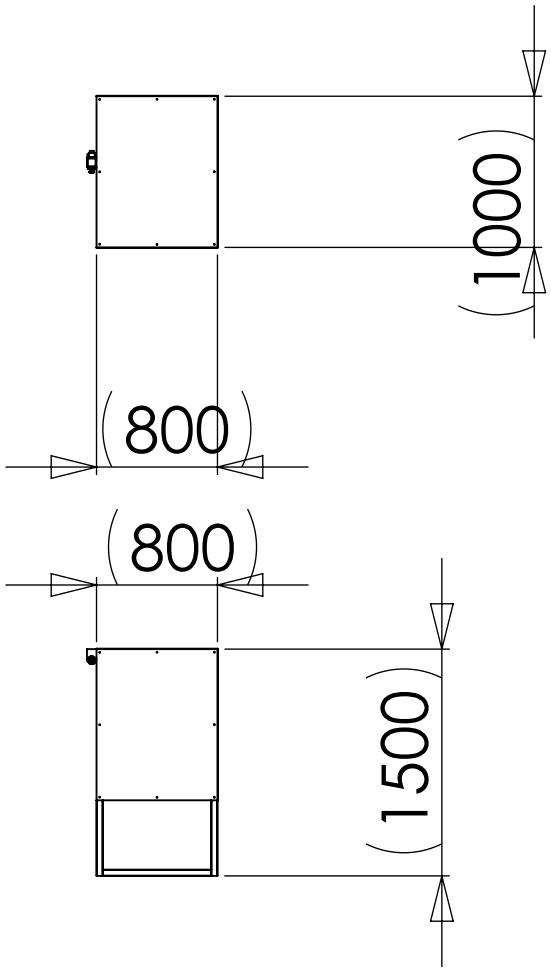
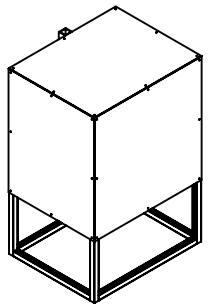
		Tolerance (mm): .127		NAME	DATE
			DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		MATERIAL As Made	Q.A.		
			COMMENTS:		
NEXT ASSY	USED ON	FINISH --			
APPLICATION		DO NOT SCALE DRAWING			

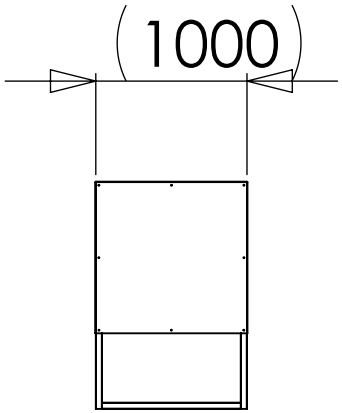
BIRDIE

Assembly, Support Beam

SIZE	DWG. NO:	REV.
A	02-01-00	
	WEIGHT:	SHEET 1 OF 1







PROPRIETARY AND CONFIDENTIAL
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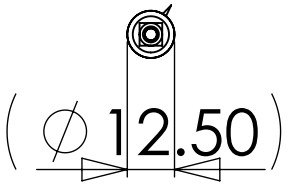
REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF BIRDIE IS PROHIBITED.

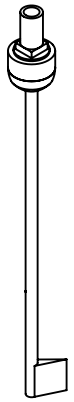
		Tolerance (mm): .127		NAME	DATE
			DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		MATERIAL As Made	Q.A.		
			COMMENTS:		
NEXT ASSY	USED ON	FINISH --			
APPLICATION		DO NOT SCALE DRAWING			

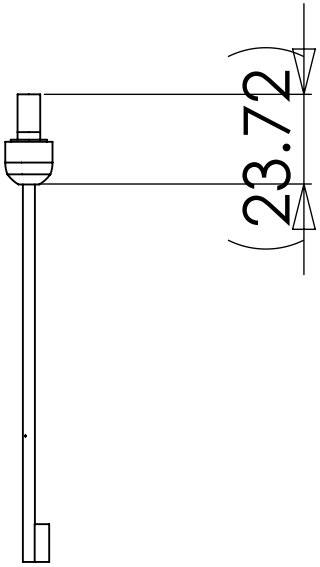
BIRDIE

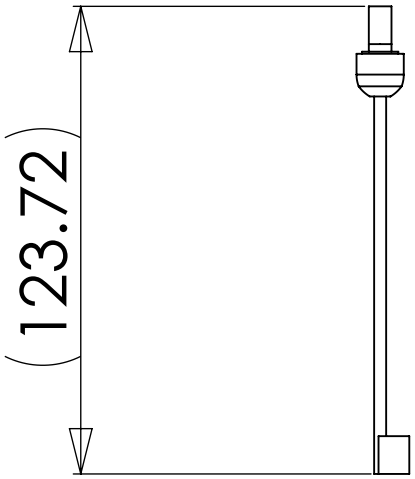
Assembly, Test Strucure

SIZE	DWG. NO:	REV.
A	02-02-00	
	WEIGHT:	SHEET 1 OF 1









PROPRIETARY AND CONFIDENTIAL
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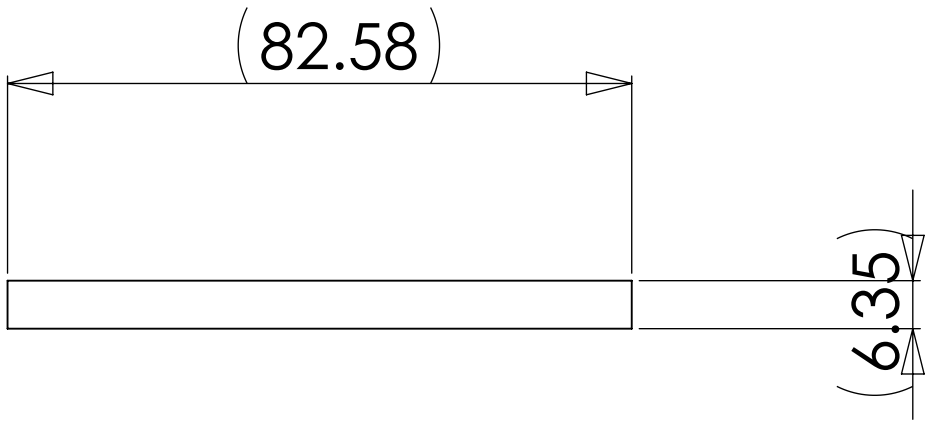
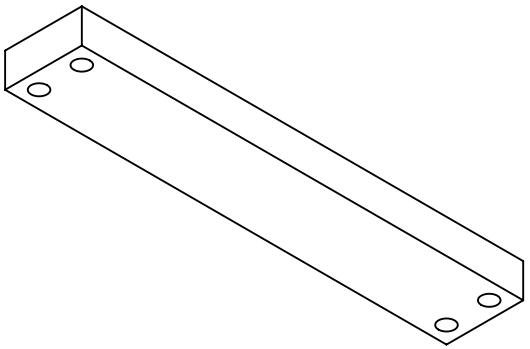
		Tolerance (mm): .127		NAME	DATE
			DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		MATERIAL As Made	Q.A.		
			COMMENTS:		
NEXT ASSY	USED ON	FINISH --			
APPLICATION		DO NOT SCALE DRAWING			

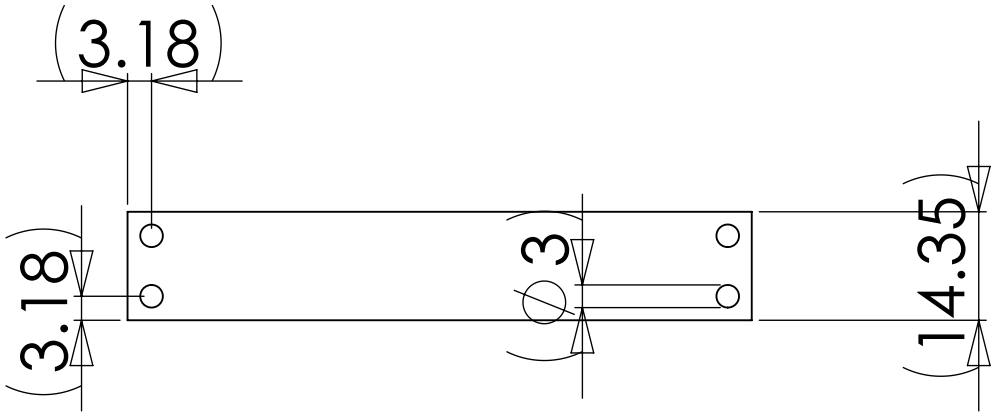
BIRDIE

Assembly, WLM

SIZE		REV.
A	DWG. NO: 01-09-00	
SCALE:1:2	WEIGHT:	SHEET 1 OF 1







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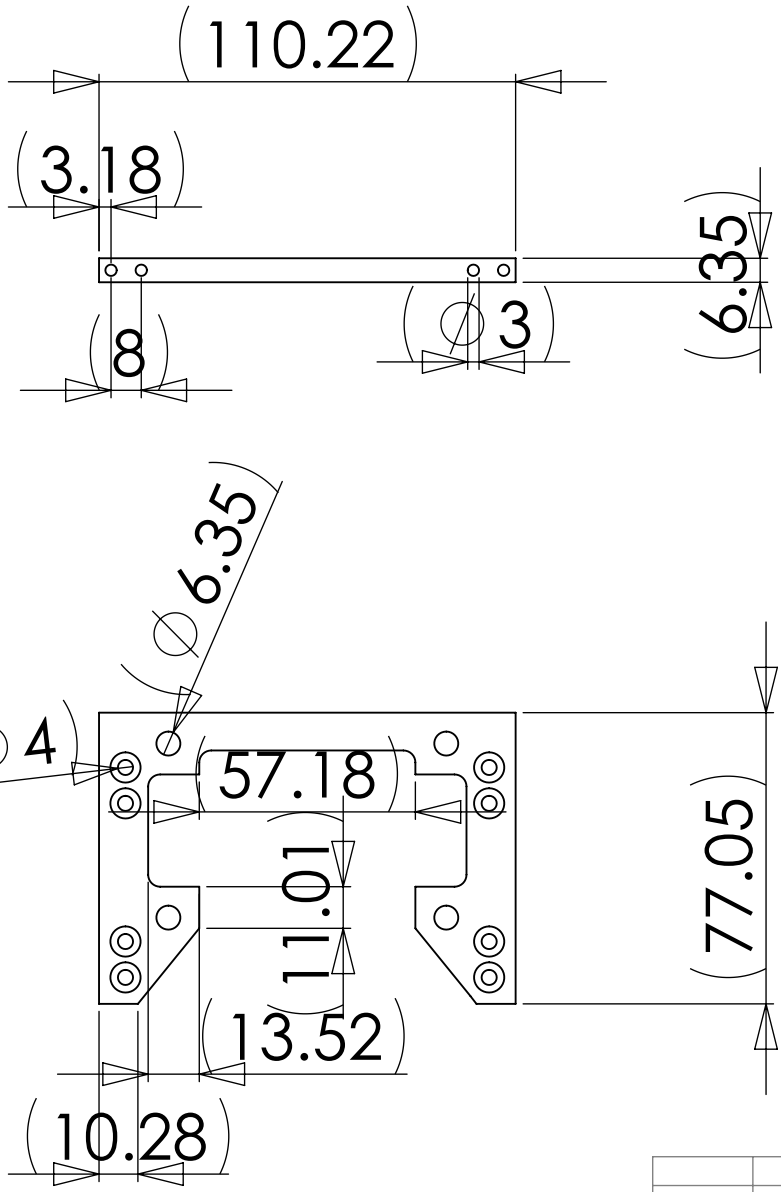
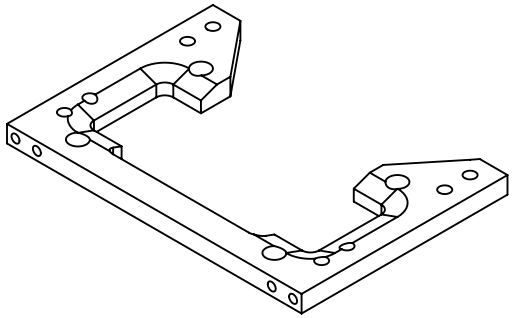
		Tolerance (mm): .127		NAME	DATE
			DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		MATERIAL Al 6061-T6	Q.A.		
			COMMENTS:		
NEXT ASSY	USED ON	FINISH --			
APPLICATION		DO NOT SCALE DRAWING			

BIRDIE

Bed, Support, Back

SIZE	DWG. NO.	REV.
A	01-01-01	
	WEIGHT:	SHEET 1 OF 1





		Tolerance (mm): .127		NAME	DATE
			DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		MATERIAL Al 6061-T6	Q.A.		
			COMMENTS:		
NEXT ASSY	USED ON	FINISH --			
APPLICATION		DO NOT SCALE DRAWING			

PROPRIETARY AND CONFIDENTIAL
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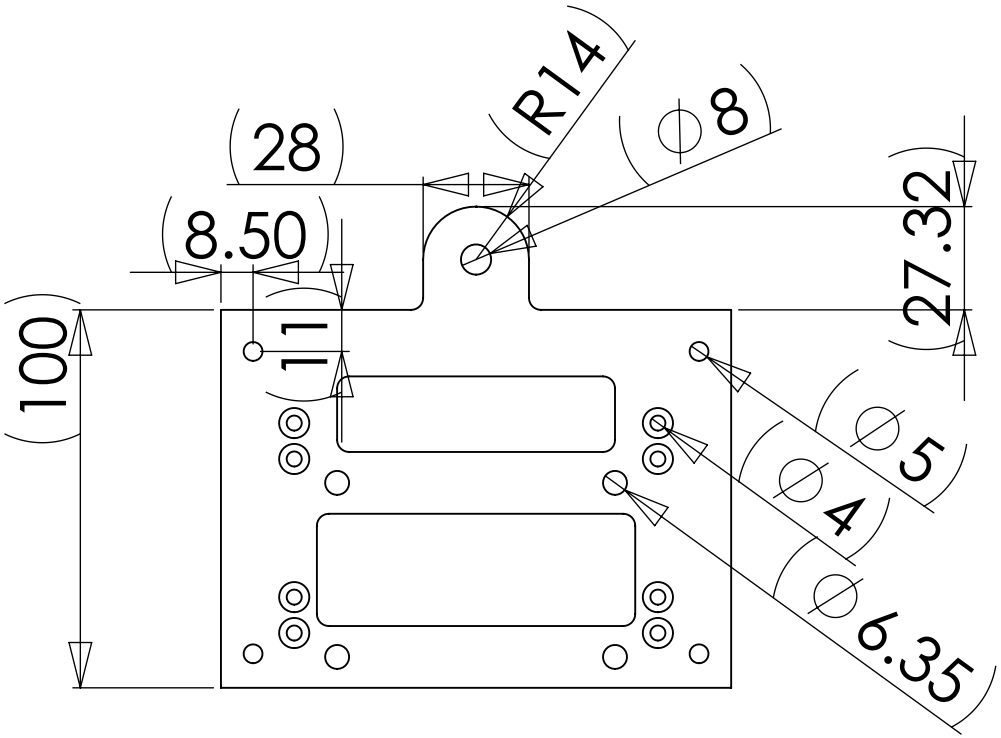
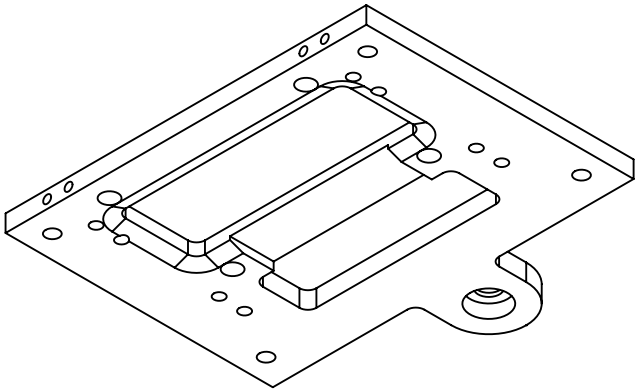
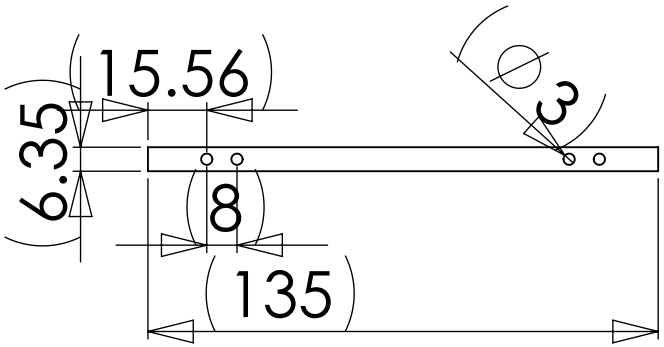
BIRDIE

Bed, Support, Lower

SIZE	DWG. NO:	REV.
A	01-01-03	
	WEIGHT:	SHEET 1 OF 1







PROPRIETARY AND CONFIDENTIAL
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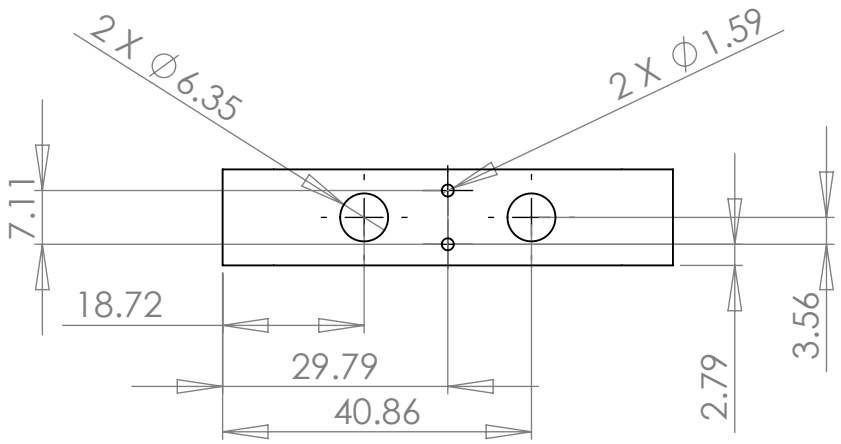
REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF BIRDIE IS PROHIBITED.

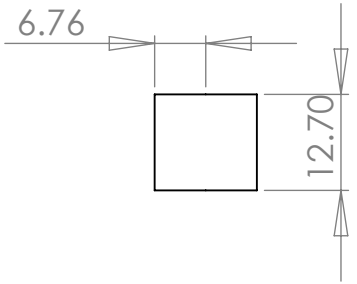
		Tolerance (mm): .127		NAME	DATE
			DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		MATERIAL Al 6061-T6	Q.A.		
			COMMENTS:		
NEXT ASSY	USED ON	FINISH --			
APPLICATION		DO NOT SCALE DRAWING			

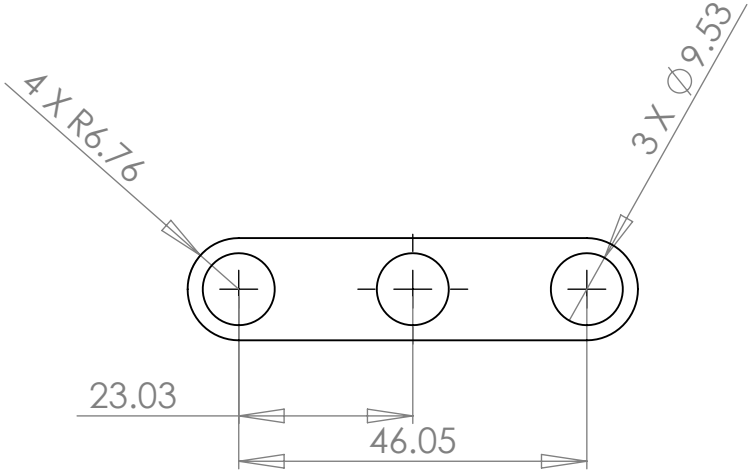
BIRDIE

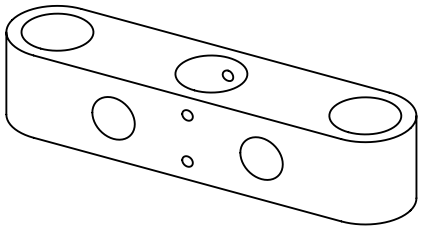
Bed Support, Upper

SIZE	DWG. NO:	REV.
A	01-01-02	
	WEIGHT:	SHEET 1 OF 1









		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		Tolerance (mm): .127	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL Al 6061-T6	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

PROPRIETARY AND CONFIDENTIAL

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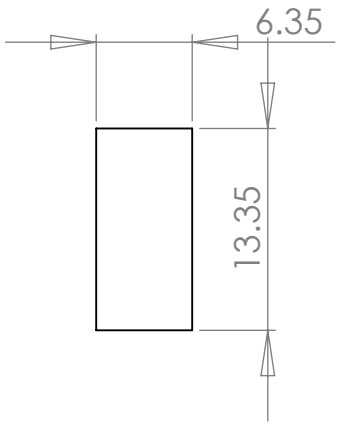
BIRDIE

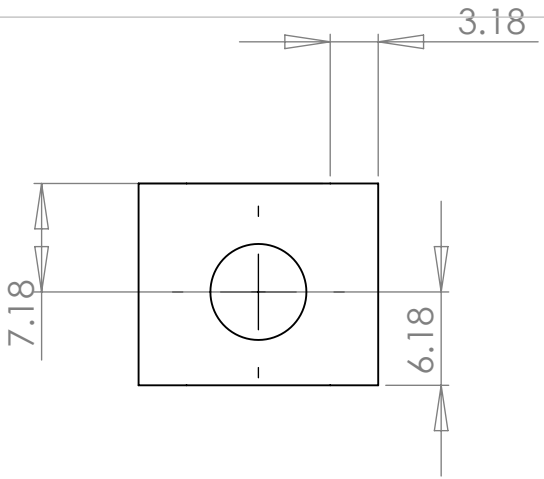
TITLE: CAG, Bracket, Control Arm Guide

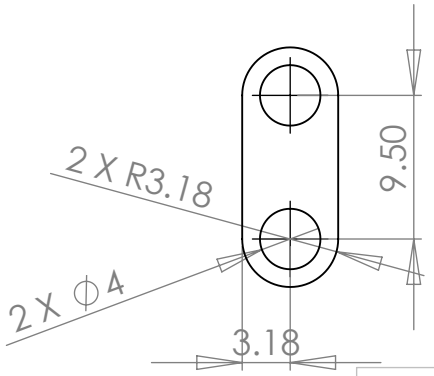
SIZE	DWG. NO.	REV
A	01-02-01	

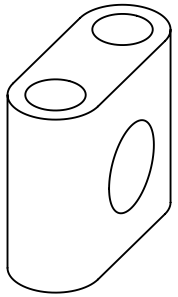
SCALE: 1:1 | WEIGHT: | SHEET 1 OF 1

5 4 3 2 1









		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		Tolerance (mm): .127	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL Al 6061-T6	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

PROPRIETARY AND CONFIDENTIAL

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BIRDIE

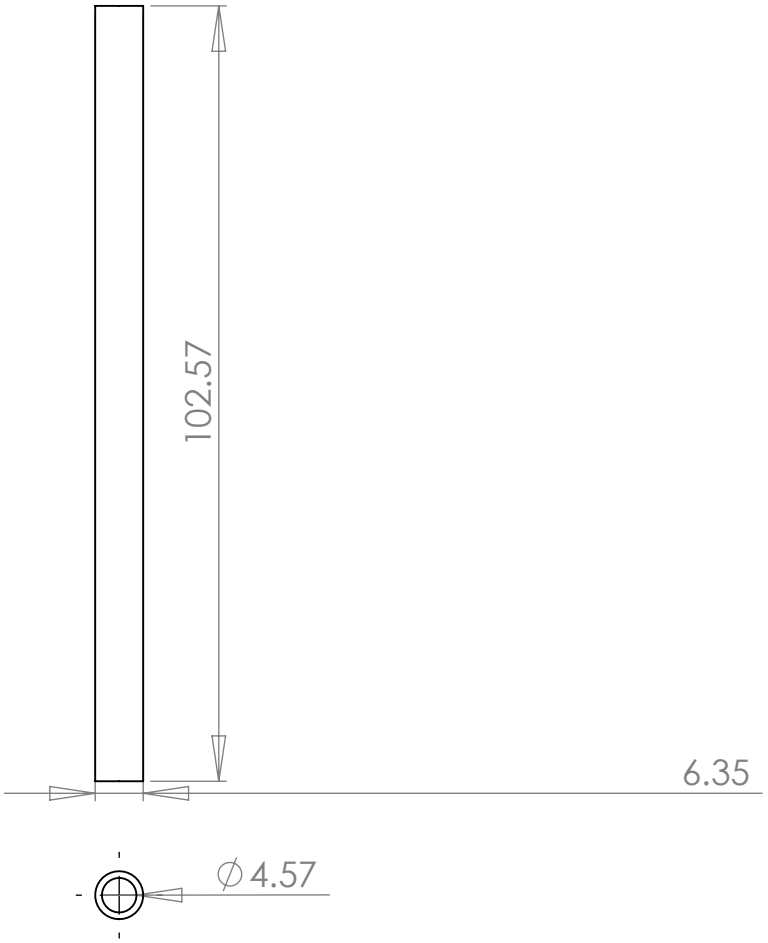
TITLE:

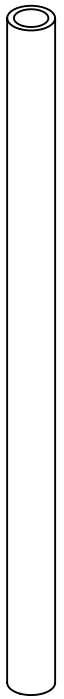
CAG, Bracket, Horizontal

SIZE	DWG. NO.	REV
A	01-01-04	

SCALE: 2:1 | WEIGHT: | SHEET 1 OF 1

5 4 3 2 1





		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		Tolerance (mm): .127	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL Al 6061-T6	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

TITLE:

CAG, Guide, Bracket, Horizontal

SIZE	DWG. NO.	REV
A	01-01-07	
SCALE: 1:2	WEIGHT:	SHEET 1 OF 1

PROPRIETARY AND CONFIDENTIAL

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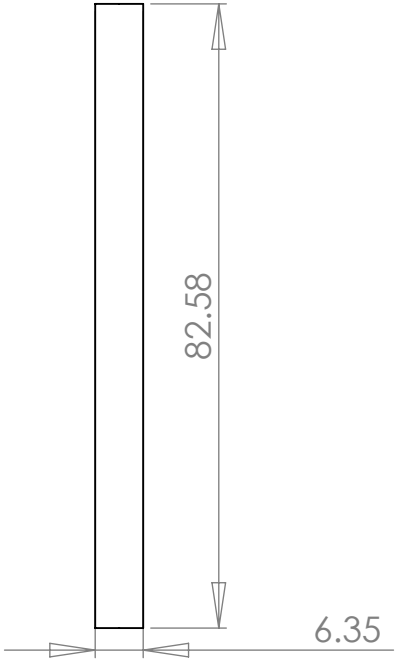
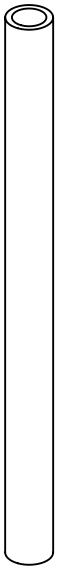
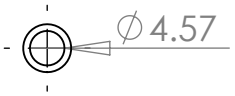
5 4 3 2 1







		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		Tolerance (mm): .127	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL Al 6061-T6	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

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BIRDIE

TITLE:

CAG, Guide, Bracket, Vertical

SIZE	DWG. NO.	REV
A	01-01-08	

SCALE: 1:2	WEIGHT:	SHEET 1 OF 1

5 4 3 2 1

		UNLESS OTHERWISE SPECIFIED:		NAME	DATE	BIRDIE
		Tolerance (mm): .127	DRAWN			
			CHECKED			TITLE:
			ENG APPR.			CAG, Guide, Control Arm, Horizontal
			MFG APPR.			
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.			
		MATERIAL Al 6061-T6	COMMENTS:			SIZE A / DWG. NO. 01-02-02 / REV
NEXT ASSY	USED ON	FINISH				
APPLICATION		DO NOT SCALE DRAWING				SCALE: 1:2 / WEIGHT: / SHEET 1 OF 1

PROPRIETARY AND CONFIDENTIAL

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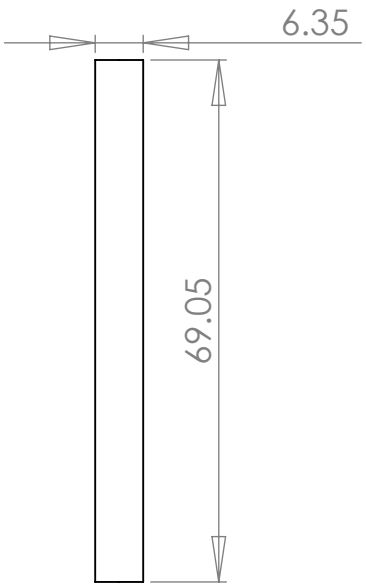
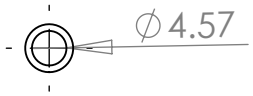
5 4 3 2 1





PROPRIETARY AND CONFIDENTIAL

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		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		Tolerances (mm): .127	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL Al 6061-T6	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

BIRDIE

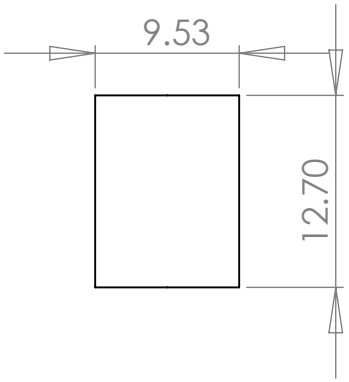
TITLE:

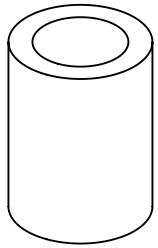
CAG, Guide, Control Arm, Vertical

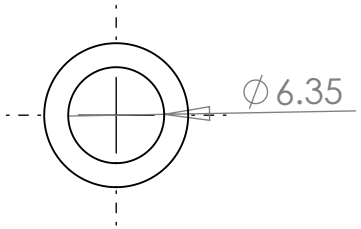
SIZE	DWG. NO.	REV
A	01-03-01	

SCALE: 1:2	WEIGHT:	SHEET 1 OF 1

5 4 3 2 1







PROPRIETARY AND CONFIDENTIAL

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		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		Tolerance (mm): .127	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL PTFE	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

BIRDIE

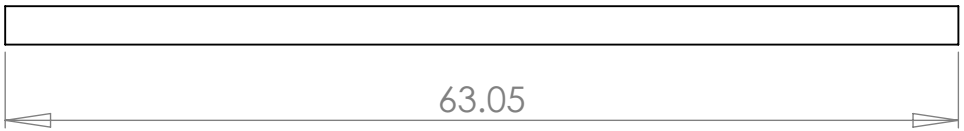
TITLE:

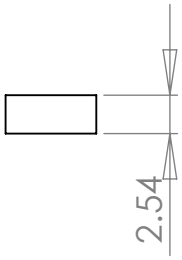
CAG, Linear Bearing

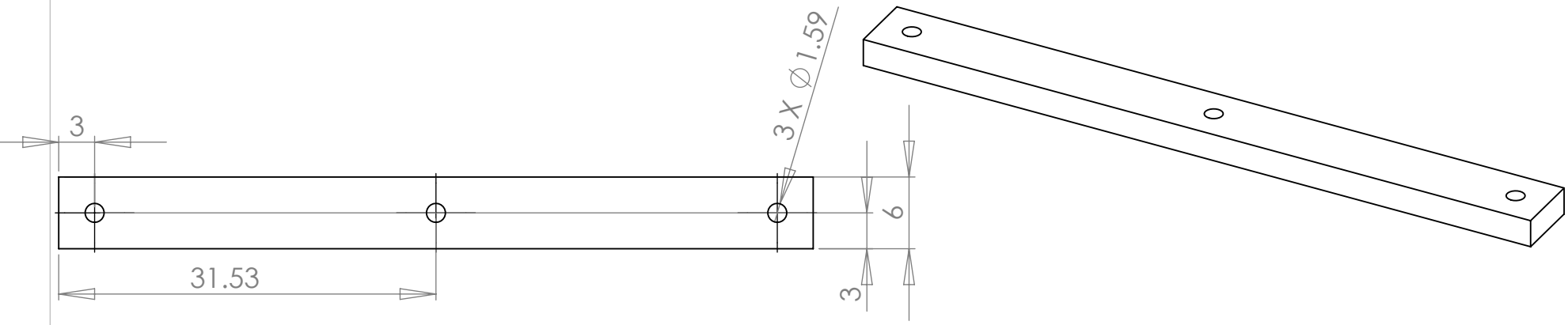
SIZE	DWG. NO.	REV
A	01-02-03	

SCALE: 2:1	WEIGHT:	SHEET 1 OF 1

5 4 3 2 1







		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		Tolerance (mm): .127	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL Al 6061-T6	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

PROPRIETARY AND CONFIDENTIAL

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BIRDIE

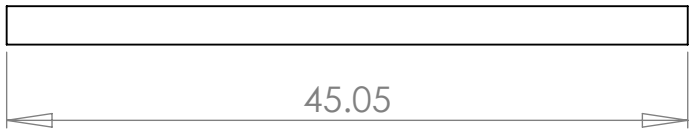
TITLE:

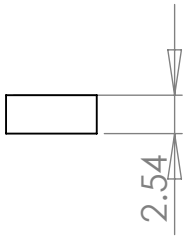
CAG, String Support, Horizontal

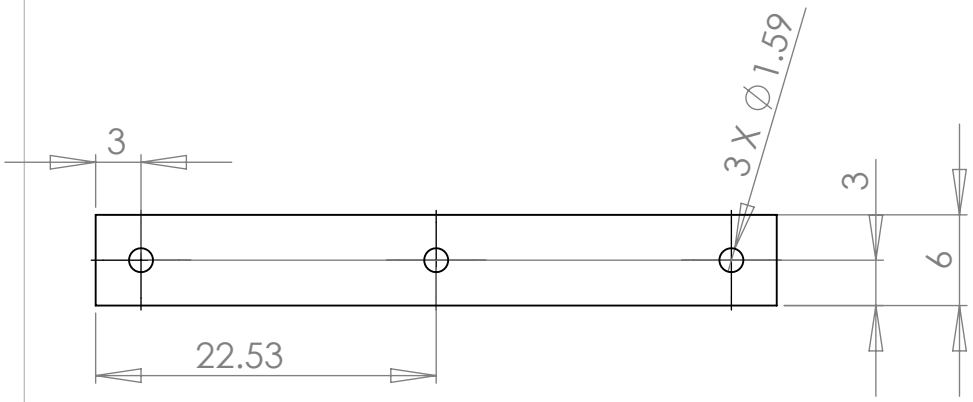
SIZE	DWG. NO.	REV
A		

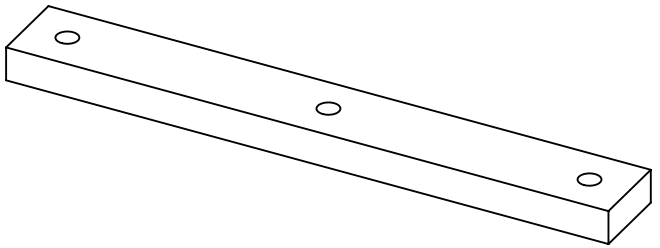
WEIGHT: SHEET 1 OF 1

5 4 3 2 1









		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		Tolerance (mm): .127	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

BIRDIE

TITLE:

CAG, String Support, Vertical

SIZE	DWG. NO.	REV
A		

SCALE: 1:1	WEIGHT:	SHEET 1 OF 1

PROPRIETARY AND CONFIDENTIAL

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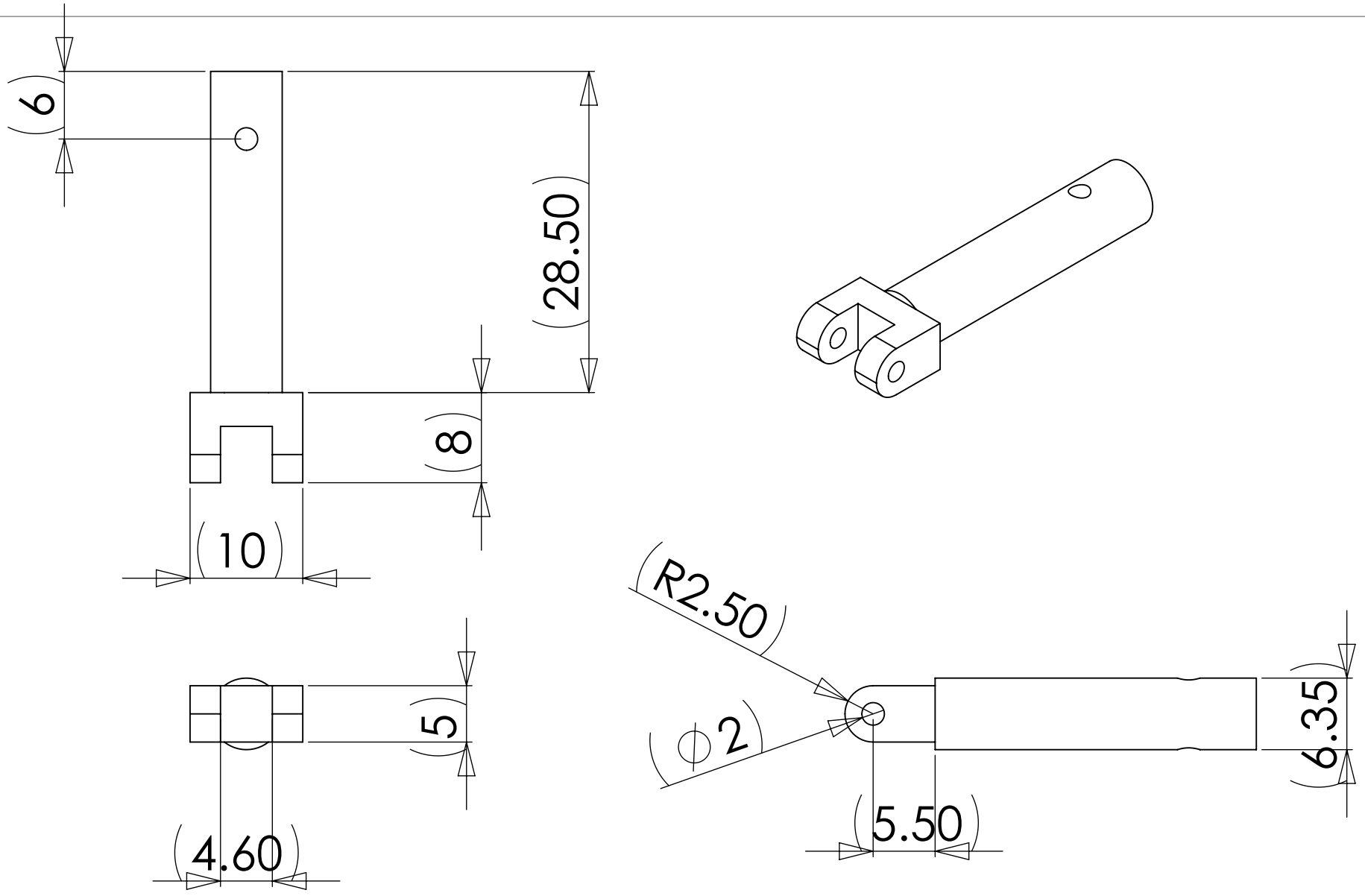
5 4 3 2 1



		Tolerance: .127 mm		NAME	DATE
			DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		MATERIAL Al 7075-T6	Q.A.		
			COMMENTS:		
NEXT ASSY	USED ON	FINISH --			
APPLICATION		DO NOT SCALE DRAWING			

PROPRIETARY AND CONFIDENTIAL
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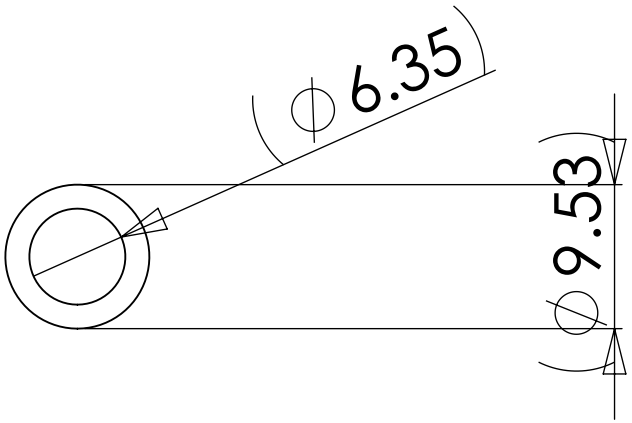
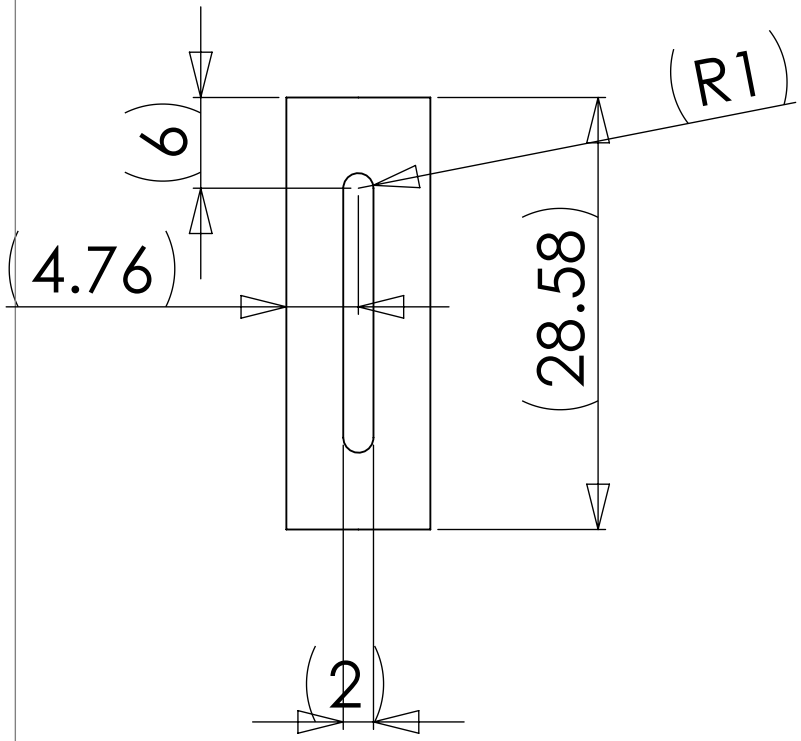
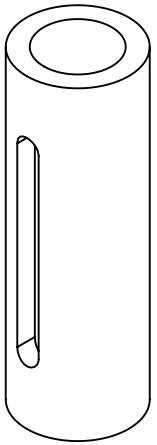
BIRDIE

Control Arm, Inner

SIZE	DWG. NO:	REV.
A	01-04-01	
	WEIGHT:	SHEET 1 OF 1







PROPRIETARY AND CONFIDENTIAL
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NEXT ASSY	USED ON
APPLICATION	

TOLERANCES (mm): .127

MATERIAL: PTFE

FINISH: --

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

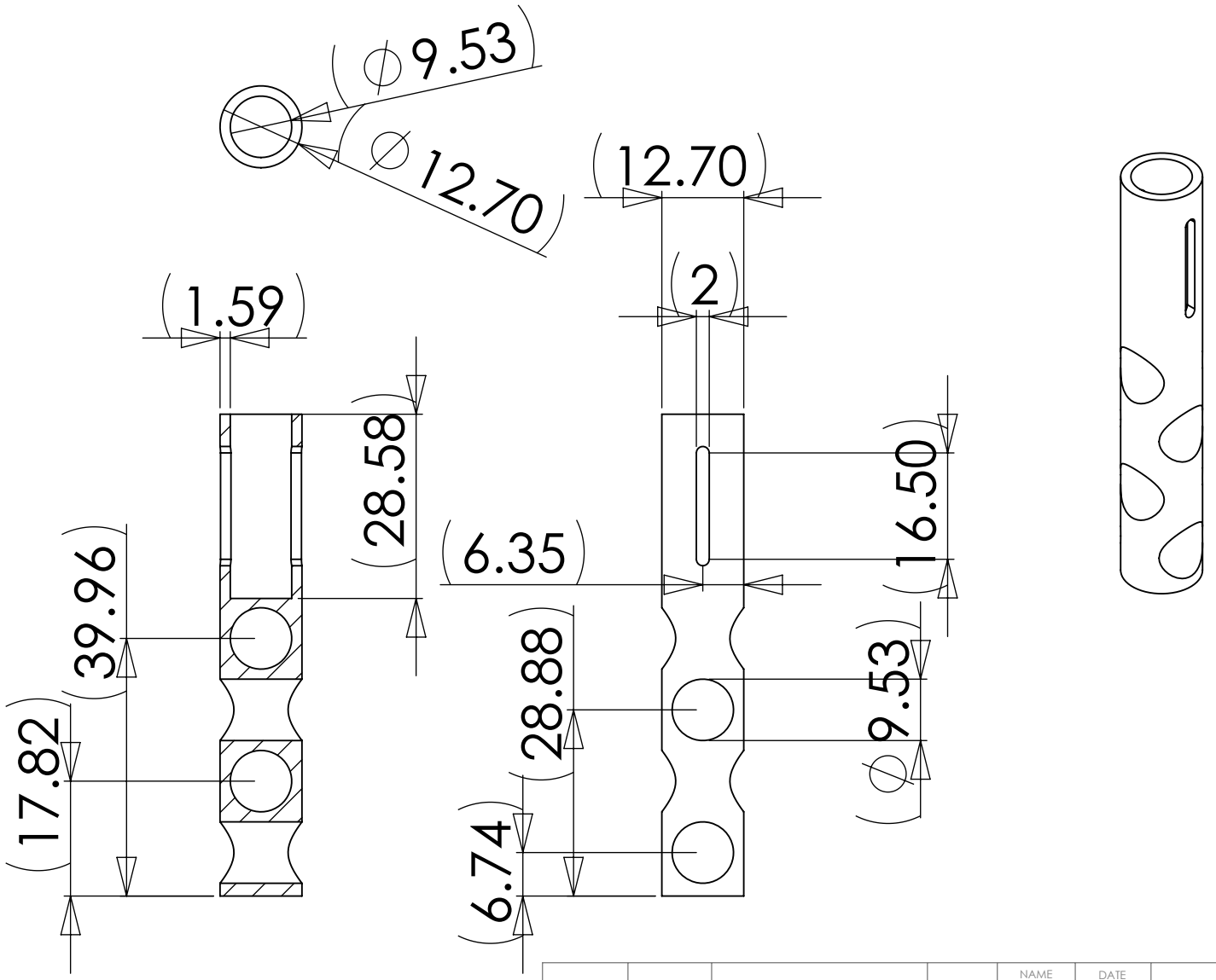
COMMENTS:

BIRDIE

Control Arm, Linear Bearing

SIZE	DWG. NO.	REV.
A	01-05-01	

WEIGHT: SHEET 1 OF 1



				NAME	DATE	
		Tolerance (mm): .127	DRAWN			BIRDIE
			CHECKED			
			ENG APPR.			
			MFG APPR.			Control Arm, Outer
		MATERIAL PTFE	Q.A.			
			COMMENTS:			
NEXT ASSY	USED ON	FINISH --				SIZE A DWG. NO: 01-05-02 REV.
APPLICATION		DO NOT SCALE DRAWING				WEIGHT: SHEET 1 OF 1

PROPRIETARY AND CONFIDENTIAL
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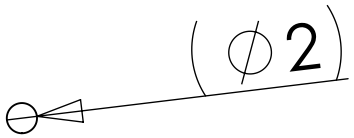

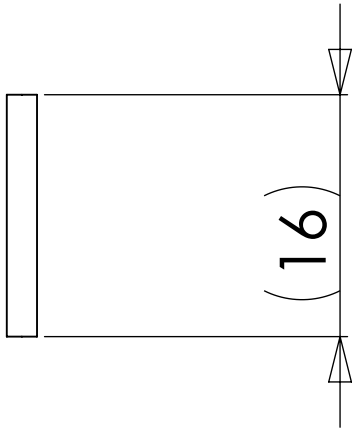

PROPRIETARY AND CONFIDENTIAL
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NEXT ASSY	USED ON
APPLICATION	

Tolerance (mm): .127

MATERIAL: 303 Stainless Steel

FINISH: --

DO NOT SCALE DRAWING

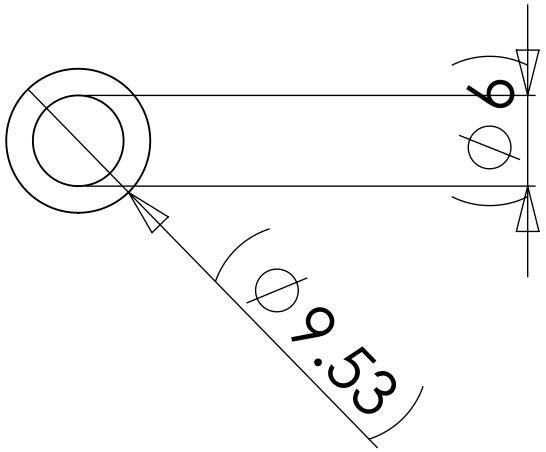
	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

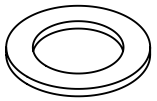
COMMENTS:

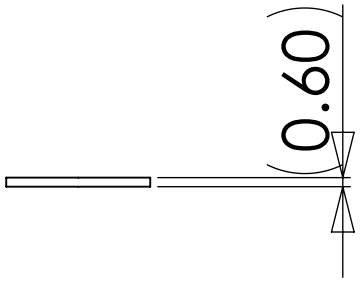
BIRDIE

Control Arm, Pin

SIZE	DWG. NO:	REV.
A	01-04-02	
	WEIGHT:	SHEET 1 OF 1







PROPRIETARY AND CONFIDENTIAL
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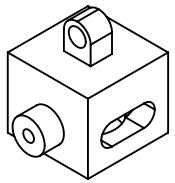
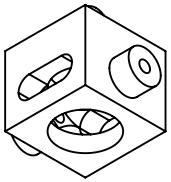
		Tolerance (mm): .127		NAME	DATE
			DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		MATERIAL Derlin	Q.A.		
			COMMENTS:		
NEXT ASSY	USED ON	FINISH --			
APPLICATION		DO NOT SCALE DRAWING			

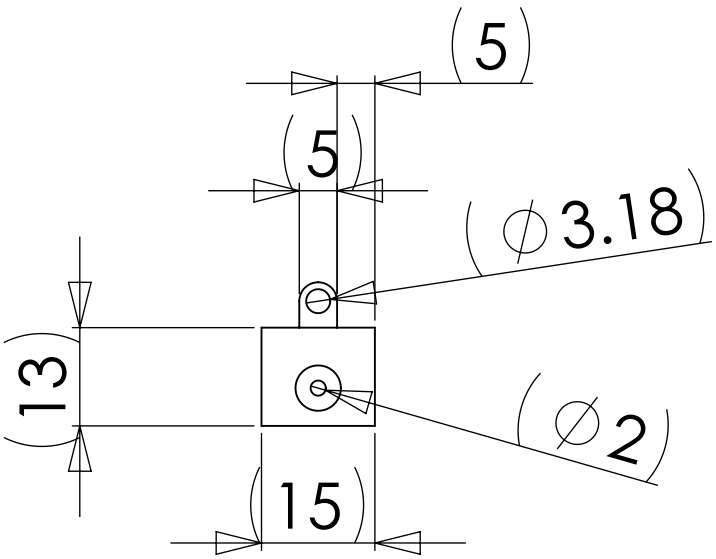
BIRDIE

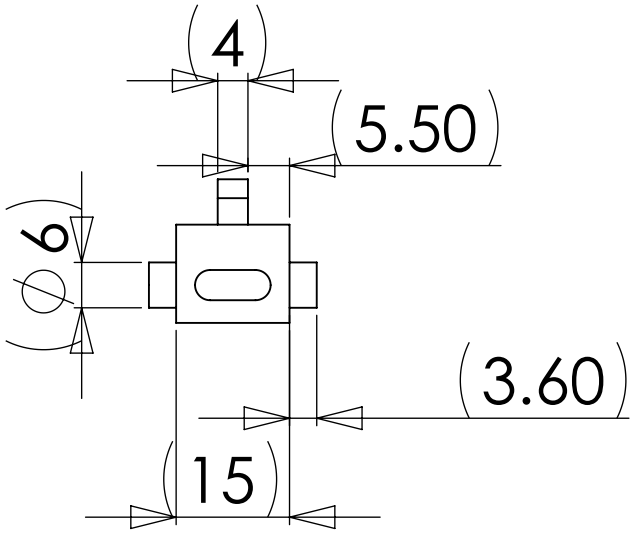
Gimbal, Gimbal y, Washer

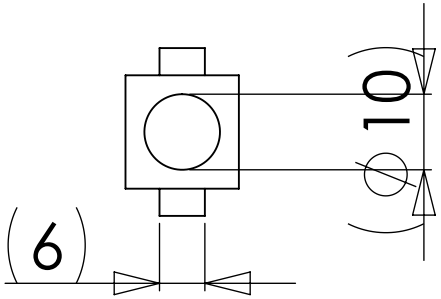
SIZE	DWG. NO:	REV.
A	01-06-02	
	WEIGHT:	SHEET 1 OF 1











		Tolerance (mm): .127		NAME	DATE
			DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		MATERIAL Al 6061-T6	Q.A.		
			COMMENTS:		
NEXT ASSY	USED ON	FINISH --			
APPLICATION		DO NOT SCALE DRAWING			

PROPRIETARY AND CONFIDENTIAL
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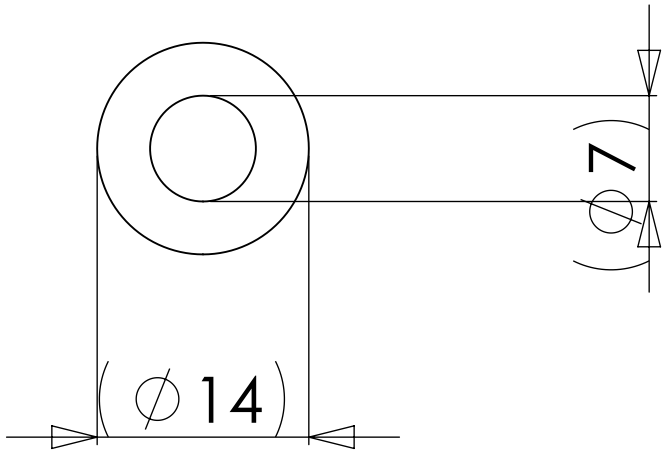
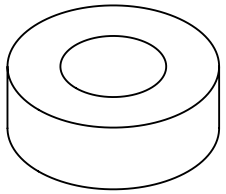
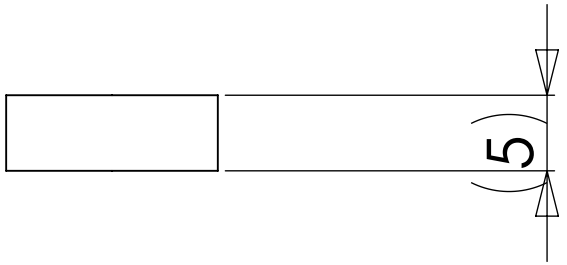
BIRDIE

Gimbal, Gimbal y

SIZE	DWG. NO:	REV.
A	01-06-01	
	WEIGHT:	SHEET 1 OF 1







PROPRIETARY AND CONFIDENTIAL
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NEXT ASSY	USED ON
APPLICATION	

Tolerance (mm): .127

MATERIAL As Purchased

FINISH --

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

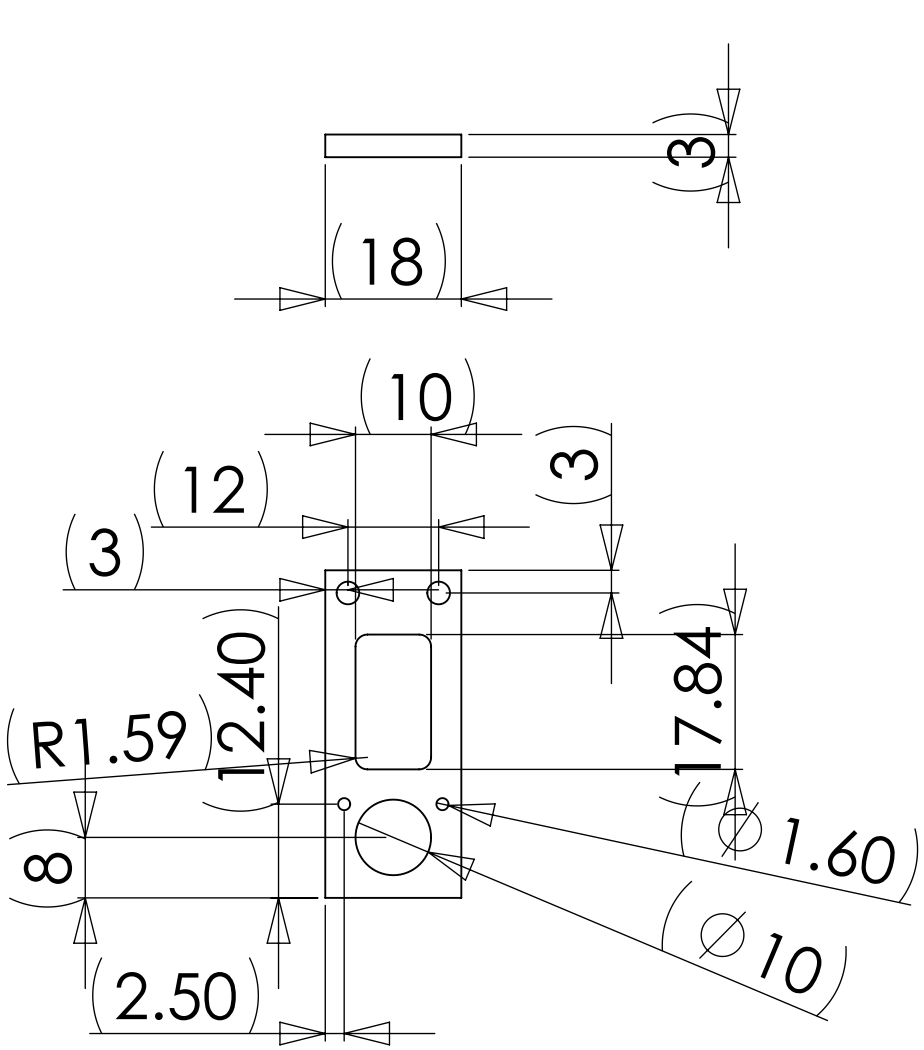
COMMENTS:

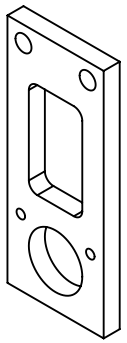
BIRDIE

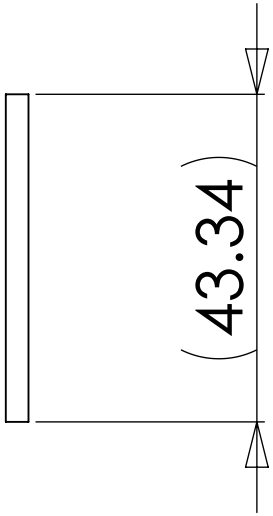
Gimbal, Gimbal z, Bearing

SIZE A | DWG. NO: 01-07-01 | REV.

WEIGHT: | SHEET 1 OF 1







		Tolerance (mm): .127		NAME	DATE
			DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		MATERIAL Al 6061-T6	Q.A.		
			COMMENTS:		
NEXT ASSY	USED ON	FINISH --			
APPLICATION		DO NOT SCALE DRAWING			

PROPRIETARY AND CONFIDENTIAL
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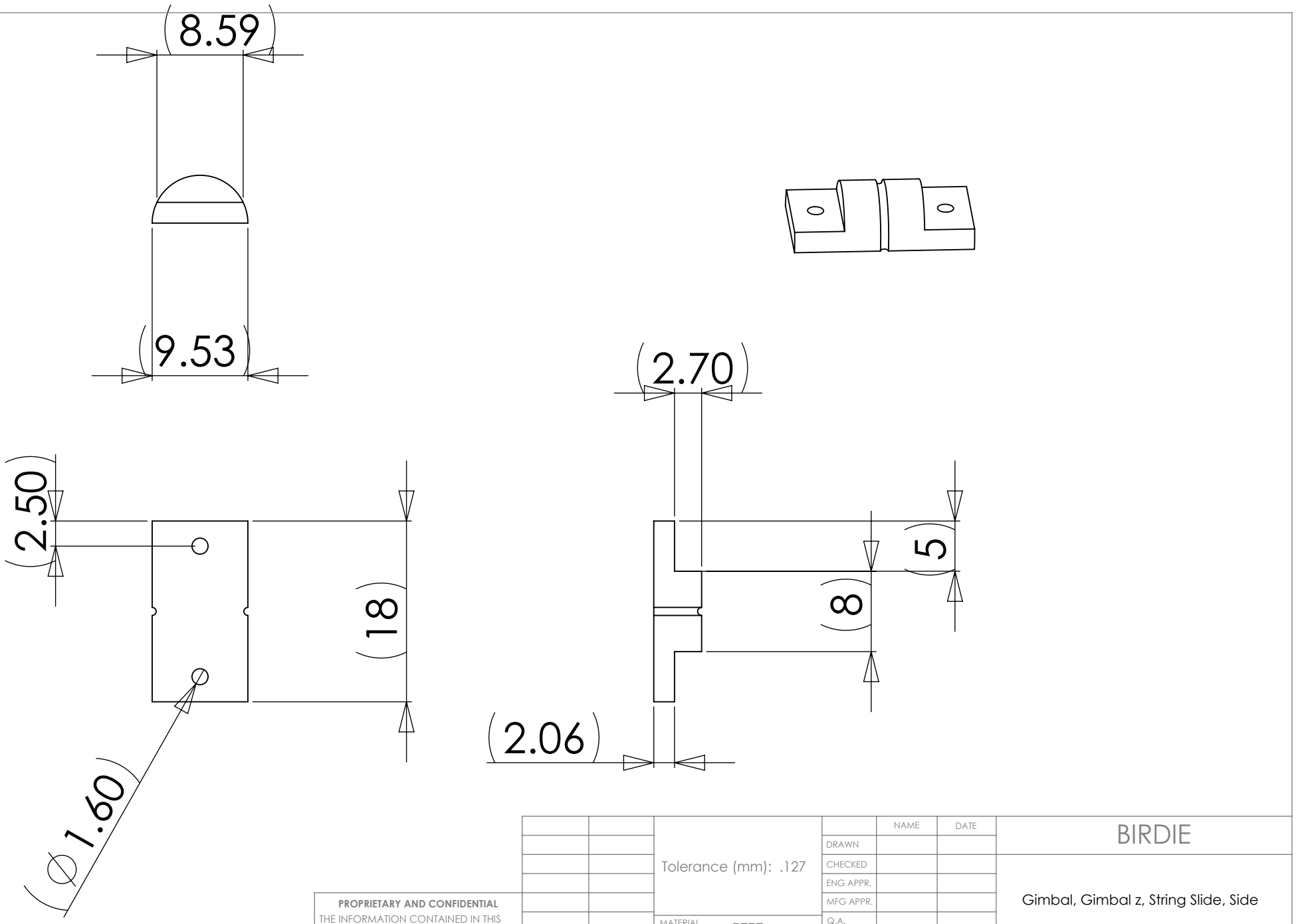
BIRDIE

Gimbal, Gimbal z, Side

SIZE	DWG. NO:	REV.
A	01-07-04	
	WEIGHT:	SHEET 1 OF 1



PROPRIETARY AND CONFIDENTIAL
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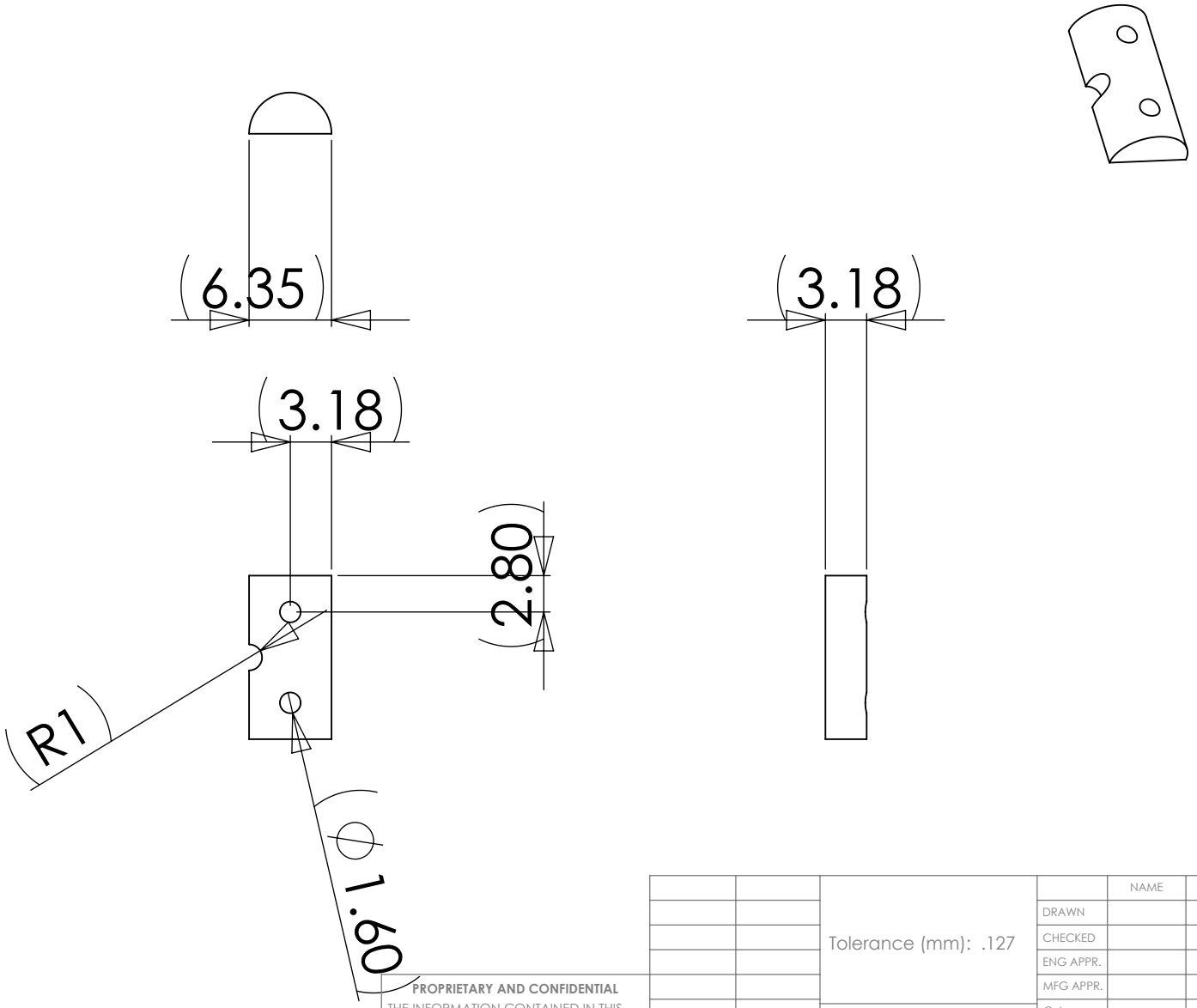
		Tolerance (mm): .127		NAME	DATE
			DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		MATERIAL PTFE	Q.A.		
			COMMENTS:		
NEXT ASSY	USED ON	FINISH --			
APPLICATION		DO NOT SCALE DRAWING			

BIRDIE

Gimbal, Gimbal z, String Slide, Side

SIZE	DWG. NO:	REV.
A	01-07-05	
	WEIGHT:	SHEET 1 OF 1



PROPRIETARY AND CONFIDENTIAL
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REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF BIRDIE IS PROHIBITED.

NEXT ASSY	USED ON
APPLICATION	

Tolerance (mm): .127

MATERIAL PTFE

FINISH --

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

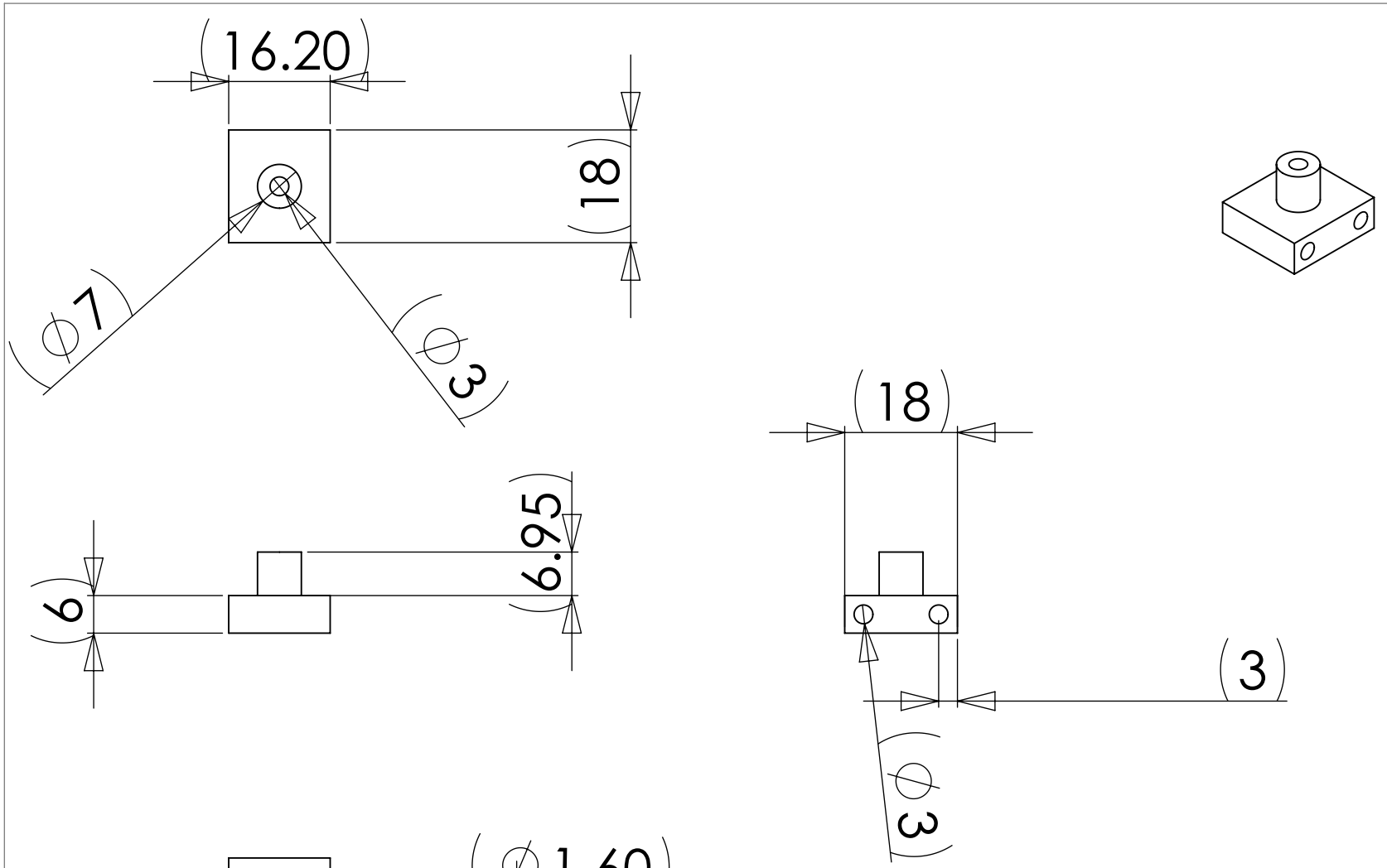
COMMENTS:

BIRDIE

Gimbal, Gimbal z, String Slide, Top

SIZE A | DWG. NO: 01-07-06 | REV.

WEIGHT: | SHEET 1 OF 1



PROPRIETARY AND CONFIDENTIAL
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF BIRDIE. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF BIRDIE IS PROHIBITED.

NEXT ASSY	USED ON	
APPLICATION		

Tolerance (mm): .127

MATERIAL: Al 6061-T6

FINISH: --

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

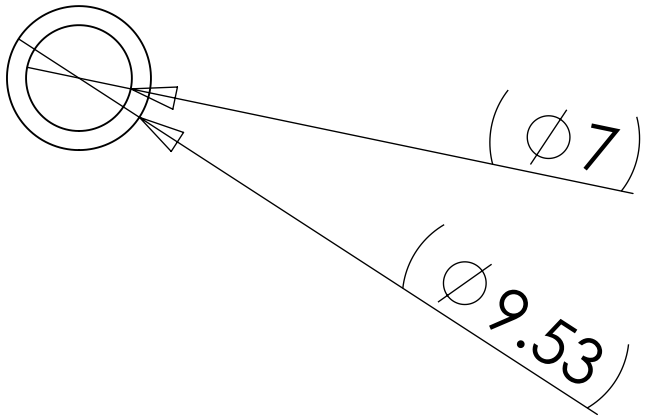
COMMENTS:

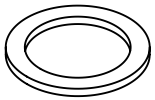
BIRDIE

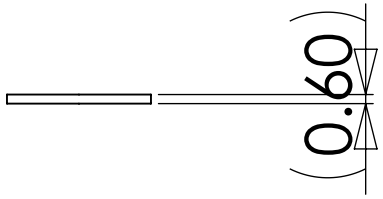
Gimbal, Gimbal z, Top

SIZE A | DWG. NO: 01-07-07 | REV.

WEIGHT: | SHEET 1 OF 1







PROPRIETARY AND CONFIDENTIAL
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF BIRDIE. ANY
REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF BIRDIE IS PROHIBITED.

NEXT ASSY	USED ON
APPLICATION	

Tolerance (mm): .127

MATERIAL Derlin

FINISH --

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

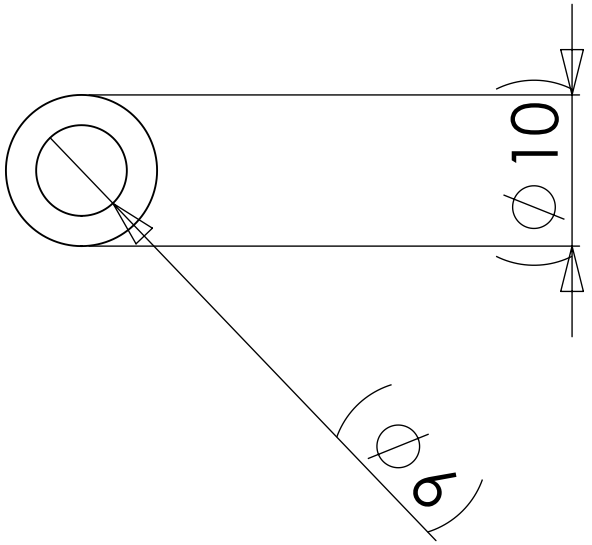
COMMENTS:

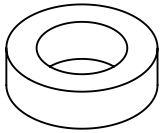
BIRDIE

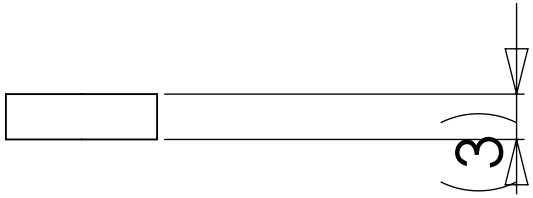
Gimbal, Gimbal z, Washer

SIZE A | DWG. NO: 01-07-08 | REV.

WEIGHT: | SHEET 1 OF 1







PROPRIETARY AND CONFIDENTIAL
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF BIRDIE. ANY
REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF BIRDIE IS PROHIBITED.

NEXT ASSY	USED ON
APPLICATION	

Tolerance (mm): .127

MATERIAL: As Purchased

FINISH: --

DO NOT SCALE DRAWING

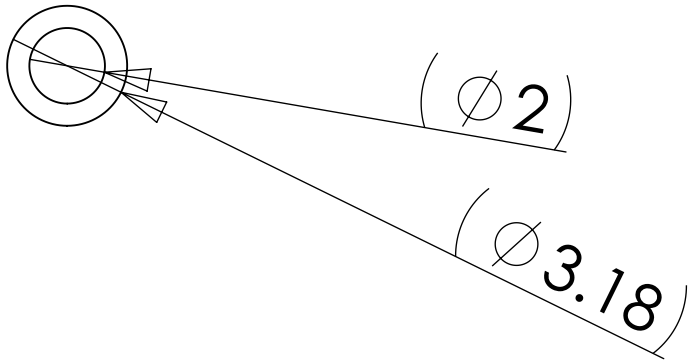
	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

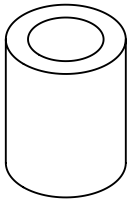
COMMENTS:

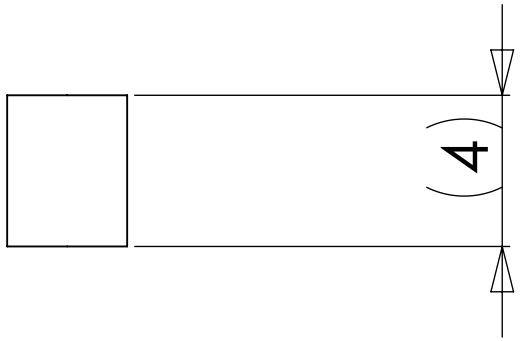
BIRDIE

Gimbal, Rotary Bearing

SIZE	DWG. NO:	REV.
A	01-06-03	
SCALE:2:1	WEIGHT:	SHEET 1 OF 1







PROPRIETARY AND CONFIDENTIAL
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NEXT ASSY	USED ON
APPLICATION	

Tolerance (mm): .127

MATERIAL: Brass C260

FINISH: --

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

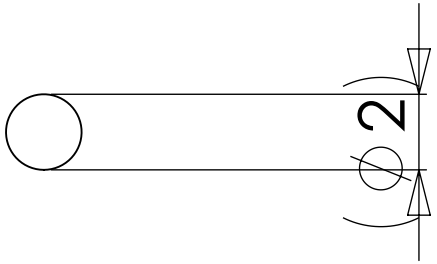
COMMENTS:

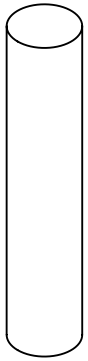
BIRDIE

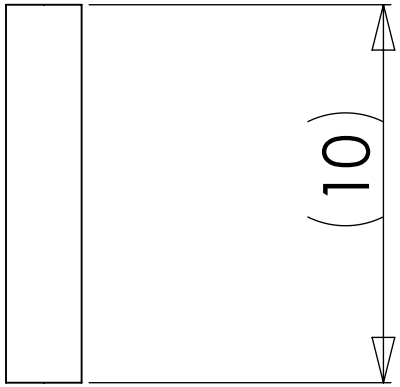
Joint,Inner

SIZE A | DWG. NO: 01-08-01 | REV.

WEIGHT: | SHEET 1 OF 1







PROPRIETARY AND CONFIDENTIAL
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REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF BIRDIE IS PROHIBITED.

NEXT ASSY	USED ON
APPLICATION	

Tolerance (mm): .127

MATERIAL 303 Stainless Steel

FINISH --

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

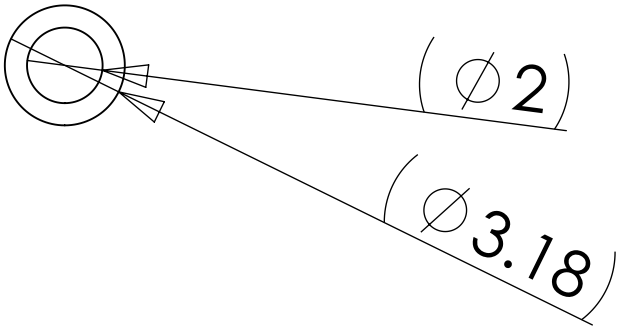
COMMENTS:

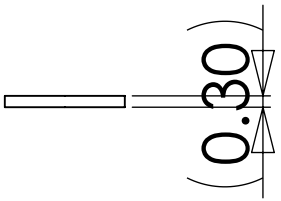
BIRDIE

Joint, Pin

SIZE A | DWG. NO: 01-08-02 | REV.

WEIGHT: | SHEET 1 OF 1





PROPRIETARY AND CONFIDENTIAL
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF BIRDIE. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF BIRDIE IS PROHIBITED.

NEXT ASSY	USED ON
APPLICATION	

Tolerance (mm): .127

MATERIAL: Brass

FINISH: --

DO NOT SCALE DRAWING

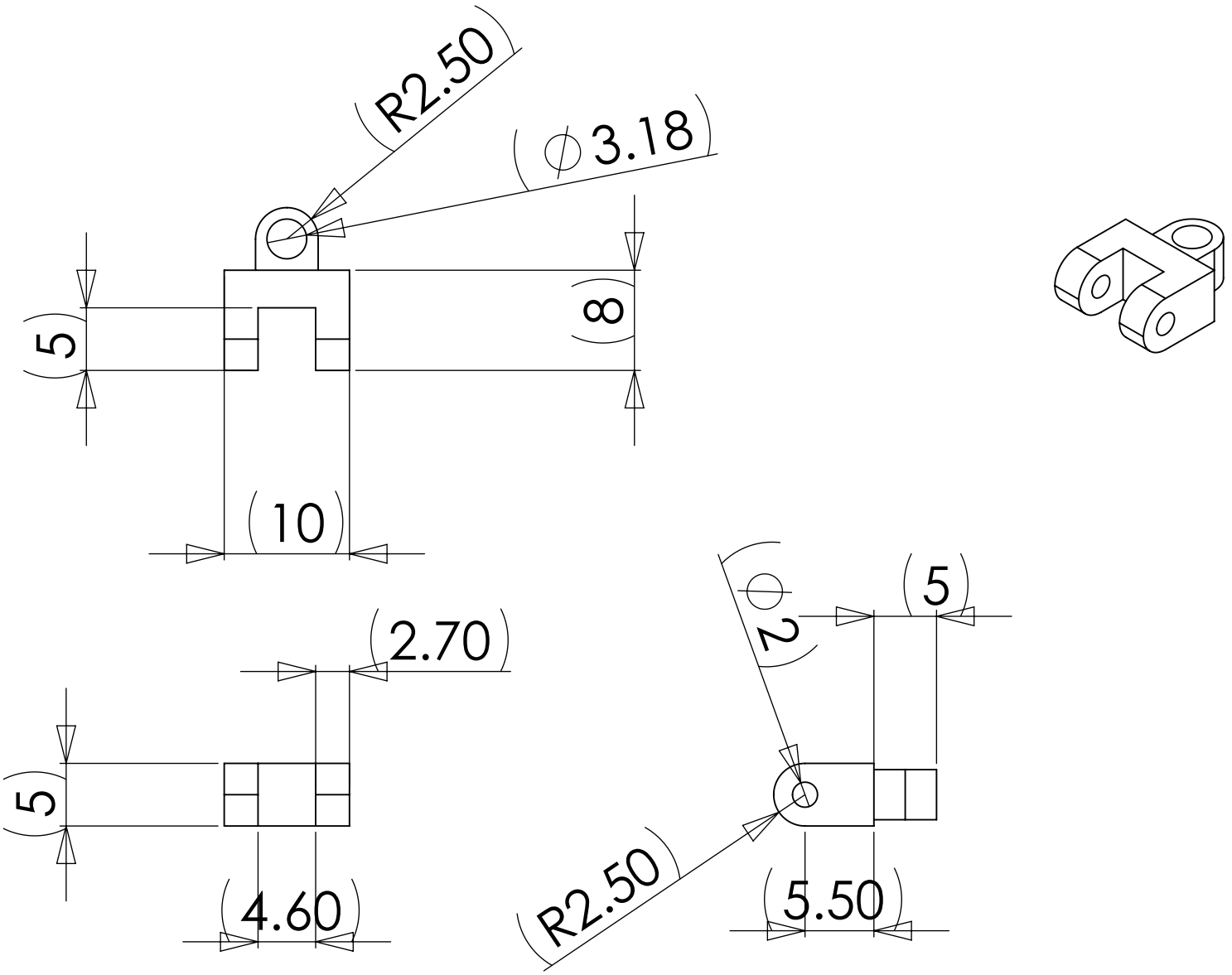
	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

BIRDIE

Joint, Washer

SIZE	DWG. NO:	REV.
A	01-08-03	
	WEIGHT:	SHEET 1 OF 1



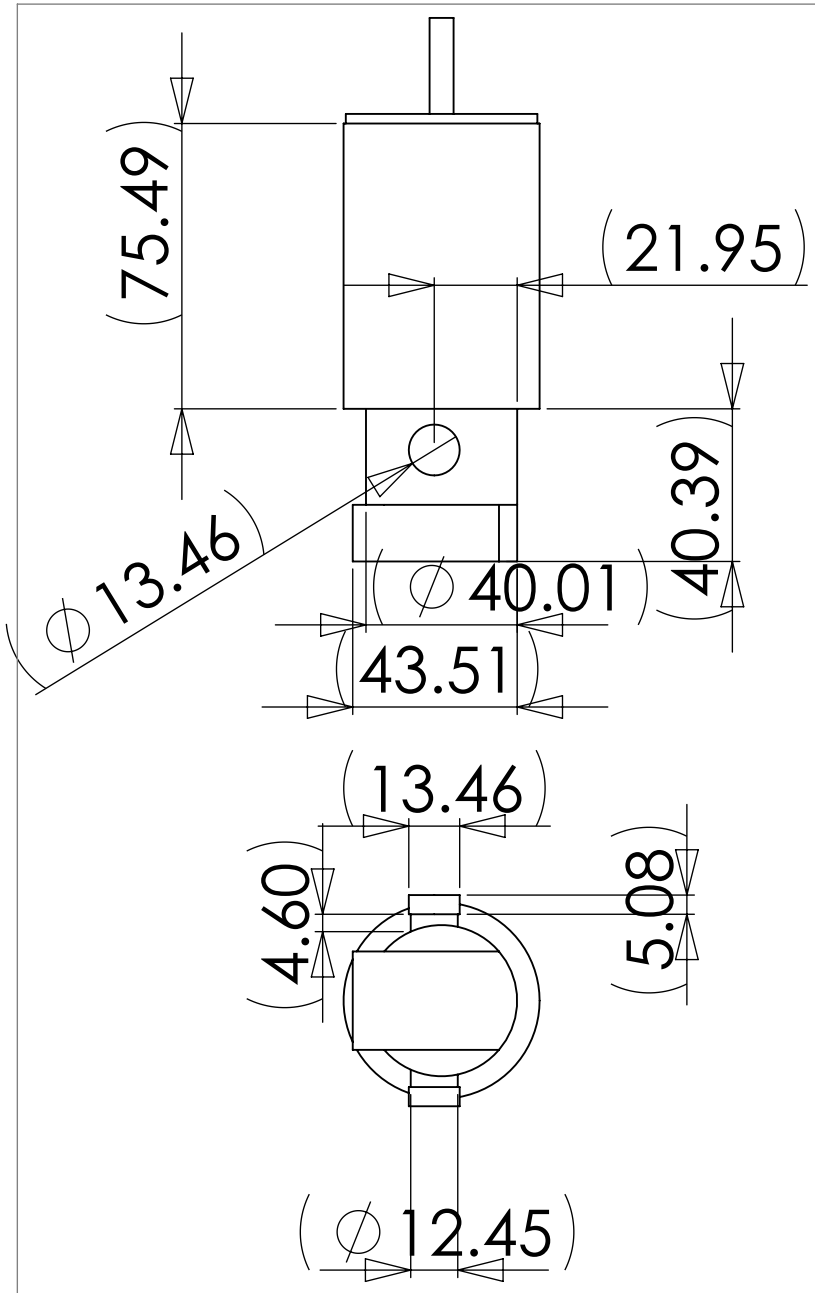
		Tolerance (mm): .127		NAME	DATE
			DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		MATERIAL Al 7075-T6	Q.A.		
			COMMENTS:		
NEXT ASSY	USED ON	FINISH --			
APPLICATION		DO NOT SCALE DRAWING			

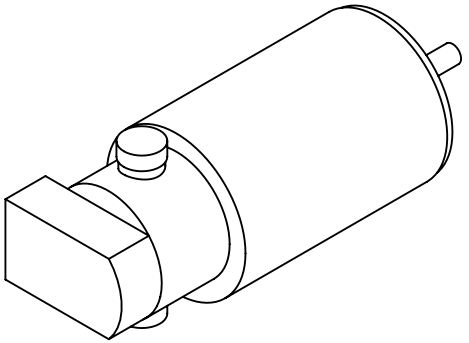
PROPRIETARY AND CONFIDENTIAL
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF BIRDIE. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF BIRDIE IS PROHIBITED.

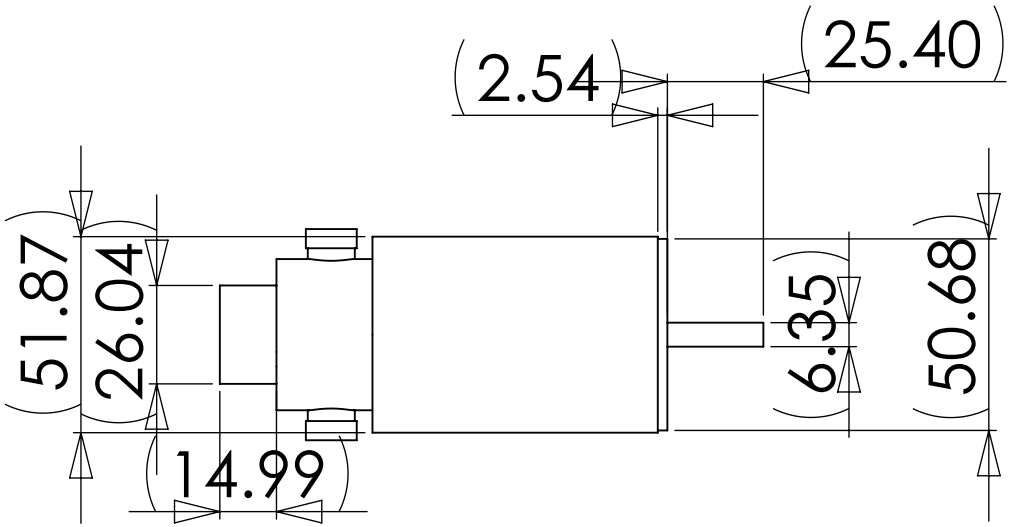
BIRDIE

Joint, y

SIZE		REV.
A	DWG. NO: 01-08-04	
	WEIGHT:	SHEET 1 OF 1







PROPRIETARY AND CONFIDENTIAL
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF BIRDIE. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF BIRDIE IS PROHIBITED.

NEXT ASSY	USED ON
APPLICATION	

MATERIAL: As Purchased
FINISH: --
DO NOT SCALE DRAWING

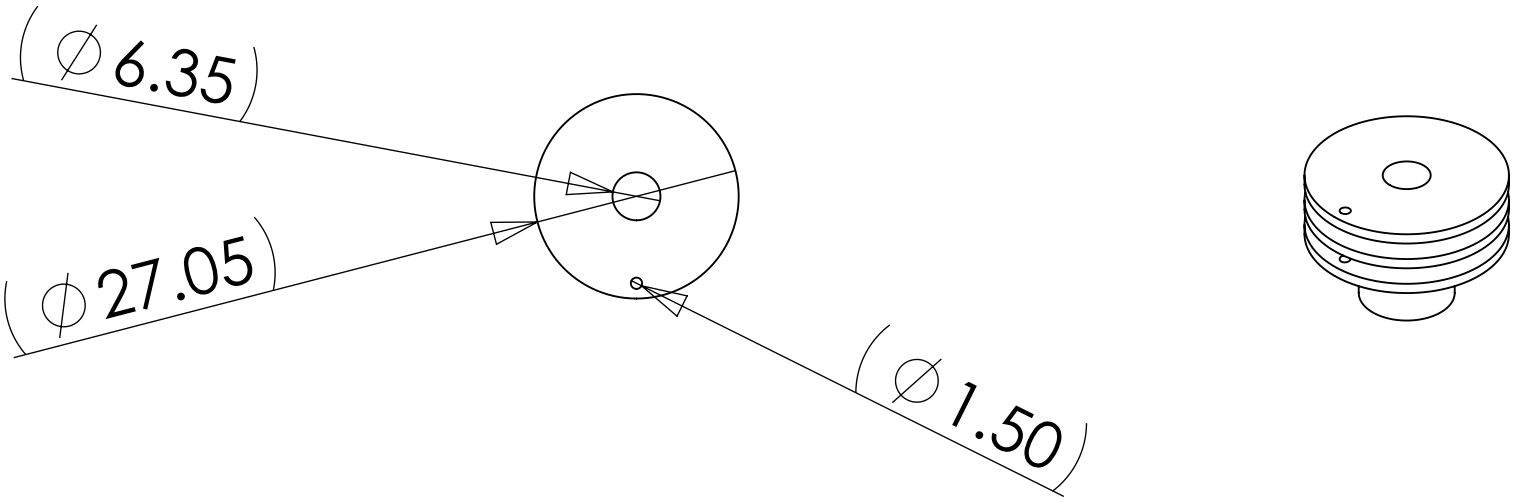
	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

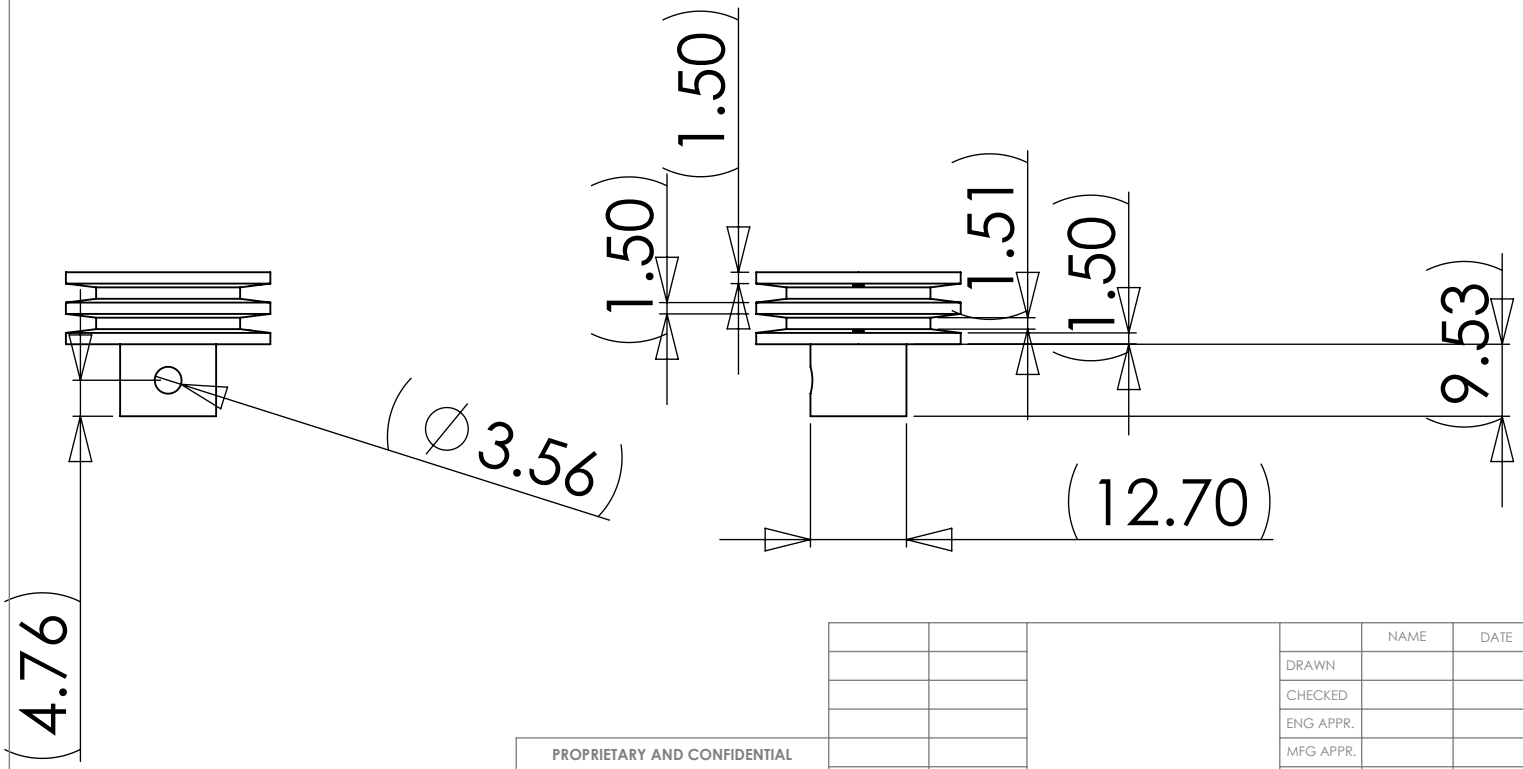
COMMENTS:

BIRDIE

Motor, Motor

SIZE A | REV.
WEIGHT: | SHEET 1 OF 1





PROPRIETARY AND CONFIDENTIAL
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			NAME	DATE
		DRAWN		
		CHECKED		
		ENG APPR.		
		MFG APPR.		
		Q.A.		
NEXT ASSY	USED ON	COMMENTS:		
APPLICATION				

MATERIAL: As Purchased

FINISH: --

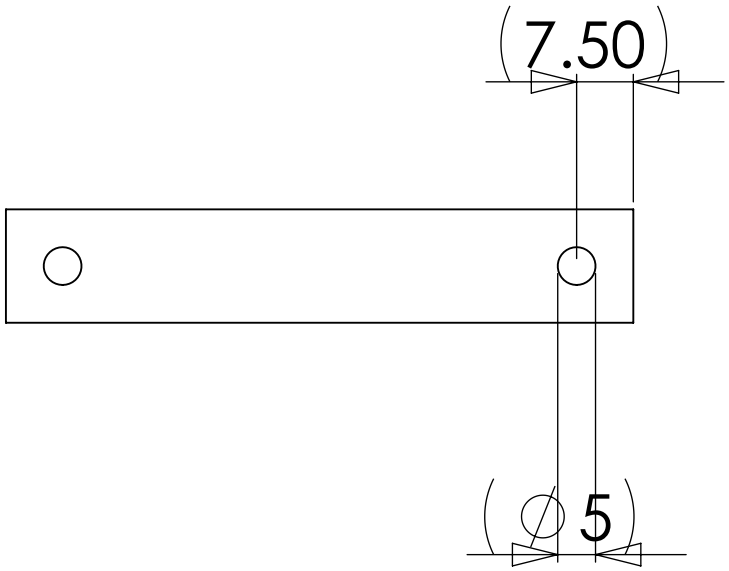
DO NOT SCALE DRAWING

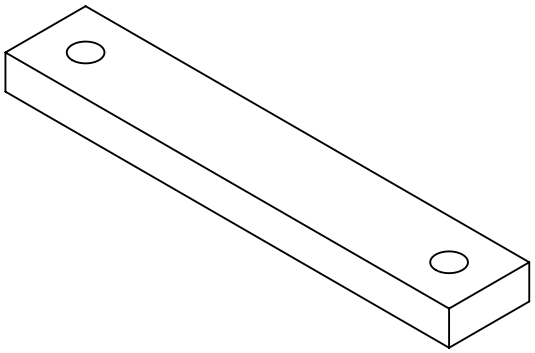
BIRDIE

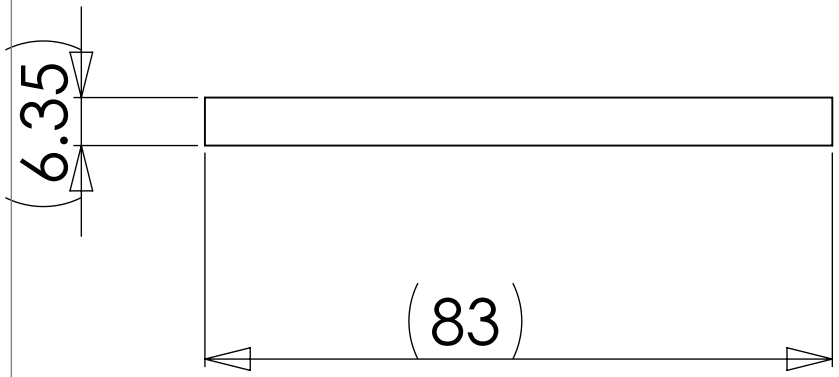
Motor, String Pulley

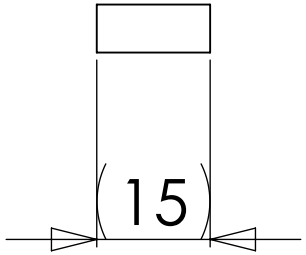
SIZE A | REV.

WEIGHT: | SHEET 1 OF 1









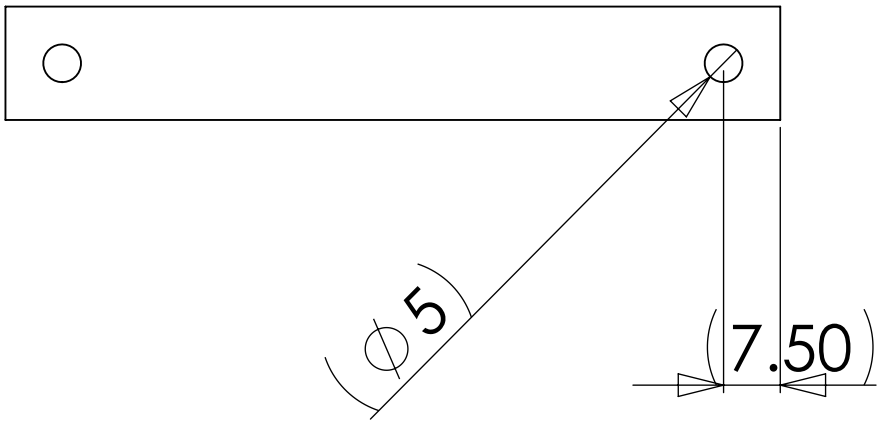
PROPRIETARY AND CONFIDENTIAL
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF BIRDIE. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF BIRDIE IS PROHIBITED.

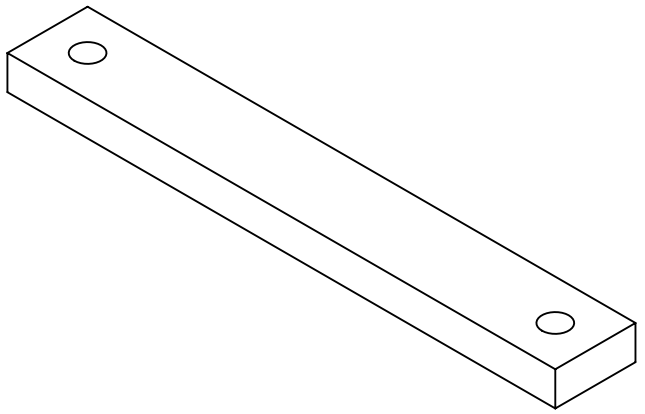
		Tolerance (mm): .127		NAME	DATE
			DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		MATERIAL Al 6061-T6	Q.A.		
			COMMENTS:		
NEXT ASSY	USED ON	FINISH --			
APPLICATION		DO NOT SCALE DRAWING			

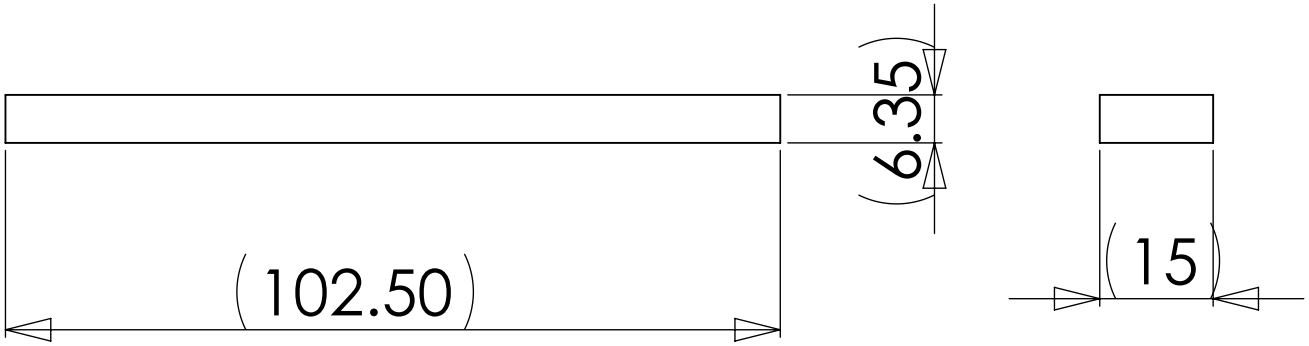
BIRDIE

Support Beam, Arm, Horizontal

SIZE		REV.
A	DWG. NO: 02-01-01	
	WEIGHT:	SHEET 1 OF 1







PROPRIETARY AND CONFIDENTIAL
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF BIRDIE. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF BIRDIE IS PROHIBITED.

NEXT ASSY	USED ON
APPLICATION	

Tolerance (mm): .127

MATERIAL: Al 6061-T6

FINISH: --

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

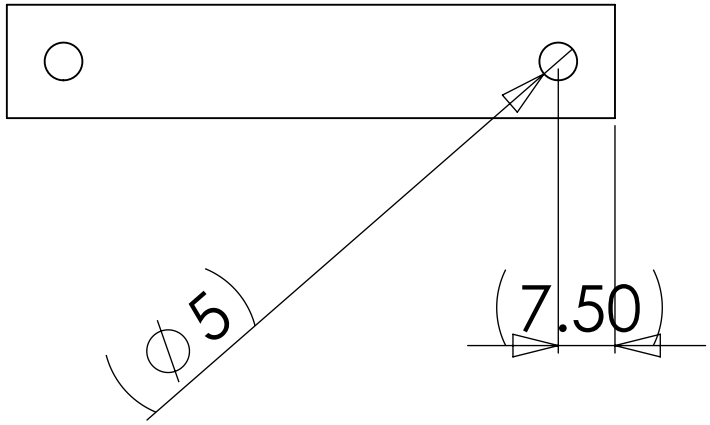
COMMENTS:

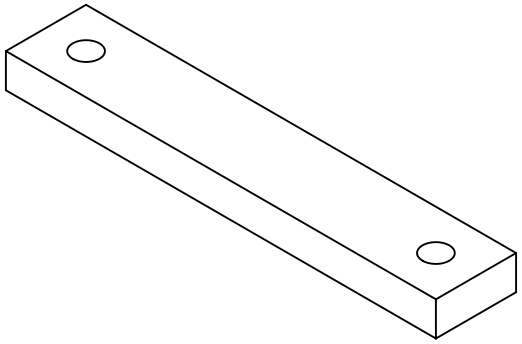
BIRDIE

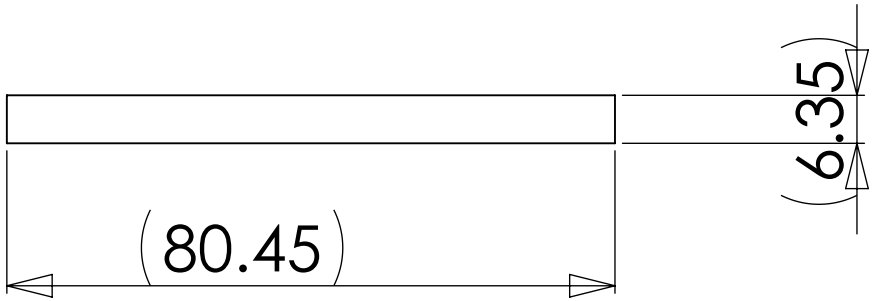
Support Beam, Arm, Vertical, Lower

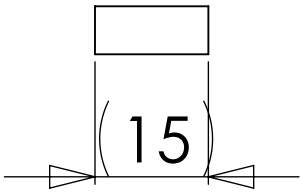
SIZE	DWG. NO:	REV.
A	02-01-02	

SCALE:1:2	WEIGHT:	SHEET 1 OF 1









PROPRIETARY AND CONFIDENTIAL
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NEXT ASSY	USED ON
APPLICATION	

Tolerance (mm): .127

MATERIAL Al 6061-T6

FINISH --

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

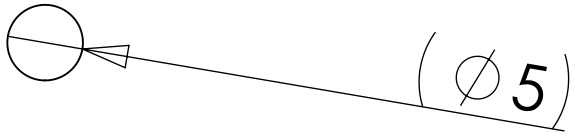
COMMENTS:

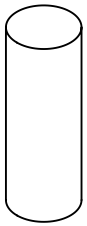
BIRDIE

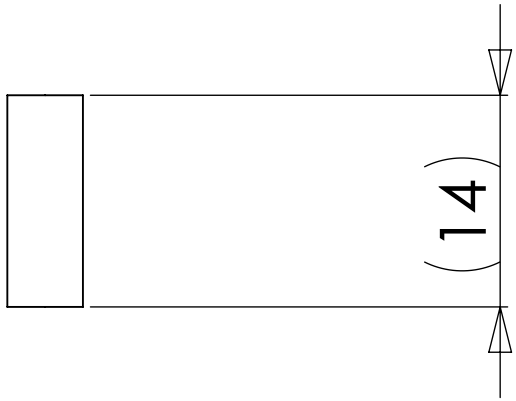
Support Beam, Arm, Vertical, Upper

SIZE	DWG. NO:	REV.
A	02-01-03	

SCALE:1:1 | WEIGHT: | SHEET 1 OF 1







PROPRIETARY AND CONFIDENTIAL
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REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF BIRDIE IS PROHIBITED.

NEXT ASSY	USED ON
APPLICATION	

Tolerance (mm): .127

MATERIAL: 303 Stainless Steel

FINISH: --

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

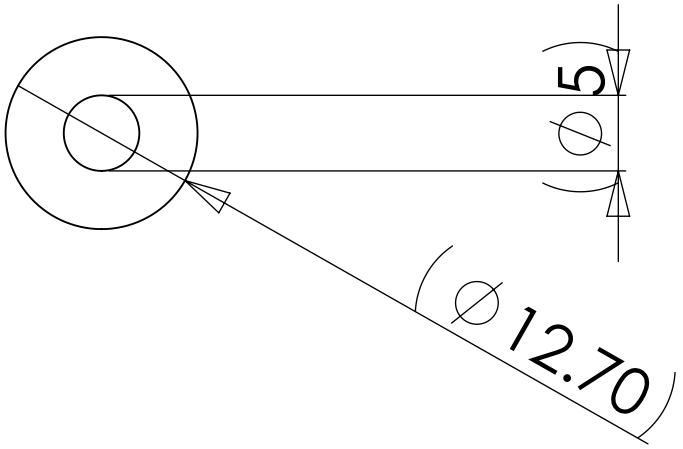
COMMENTS:

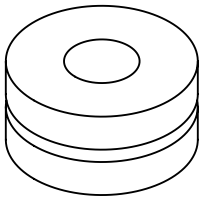
BIRDIE

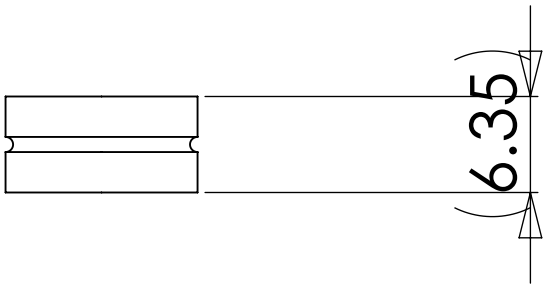
Support Beam, Pin

SIZE A | DWG. NO: 02-01-05 | REV.

SCALE:2:1 | WEIGHT: | SHEET 1 OF 1







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NEXT ASSY	USED ON
APPLICATION	

Tolerance (mm): .127

MATERIAL PTFE

FINISH --

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
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ENG APPR.		
MFG APPR.		
Q.A.		

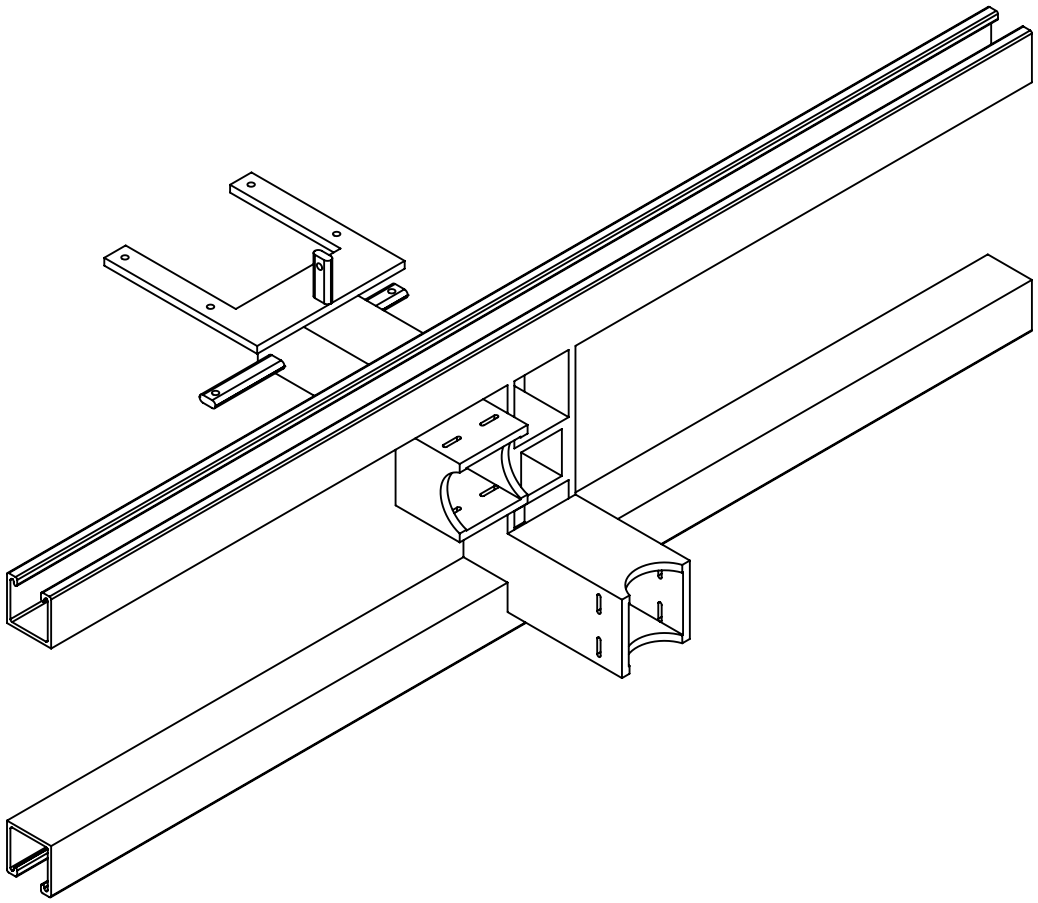
COMMENTS:

BIRDIE

Support Beam, Roller

SIZE	DWG. NO:	REV.
A	02-01-06	

SCALE:2:1 | WEIGHT: | SHEET 1 OF 1



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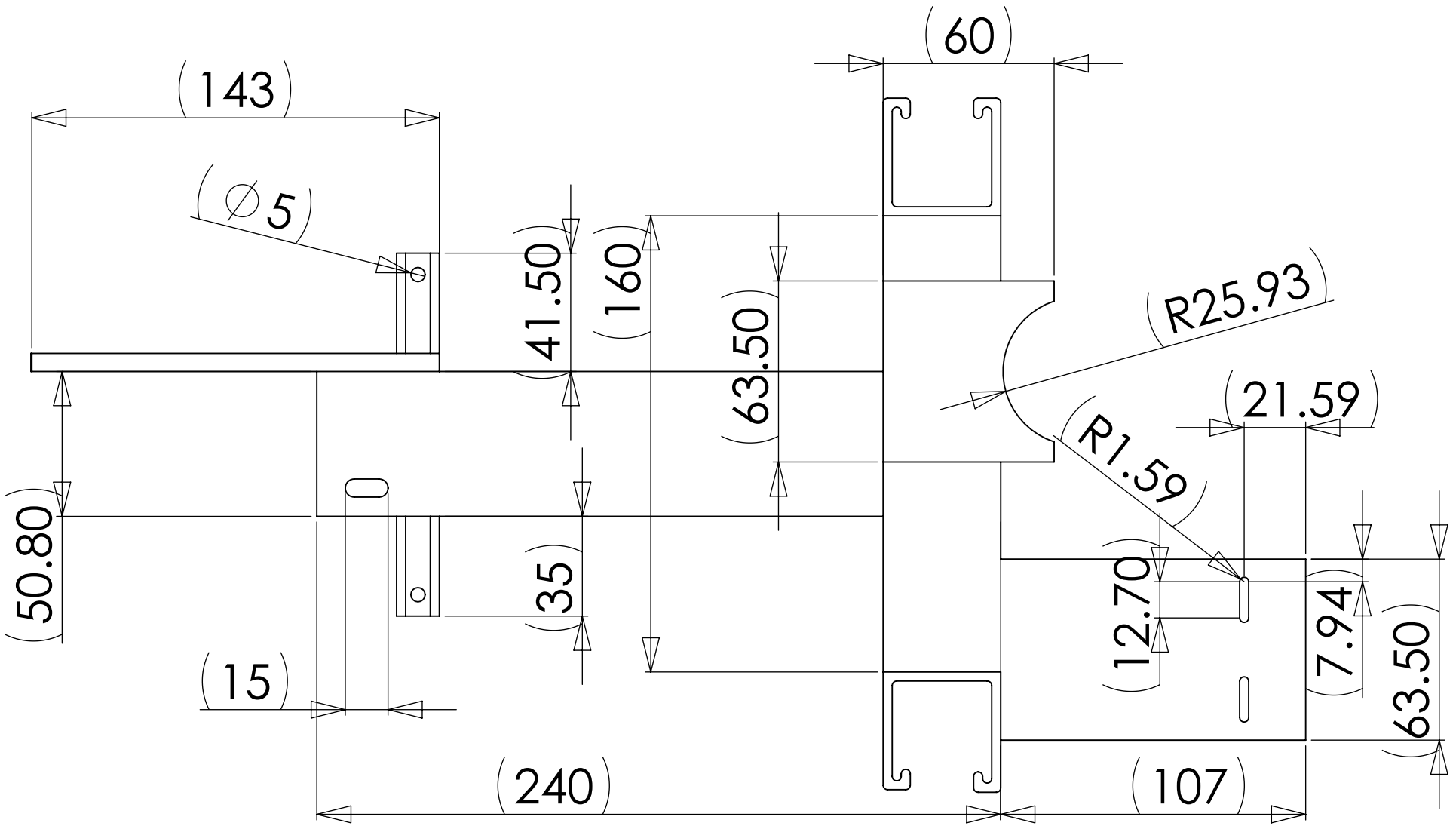
BIRDIE

SIZE	DWG. NO.	REV.
A	02-01-00	

SCALE:1:10 | WEIGHT: | SHEET 1 OF 5



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			CHECKED			
			ENG APPR.			
			MFG APPR.			
			Q.A.			
		INTERPRET GEOMETRIC TOLERANCING PER:	COMMENTS:			SIZE A DWG. NO. REV
		MATERIAL				Support Beam, Support Be
NEXT ASSY	USED ON	FINISH				
APPLICATION		DO NOT SCALE DRAWING				SCALE: 1:10 WEIGHT: SHEET 2 OF 5

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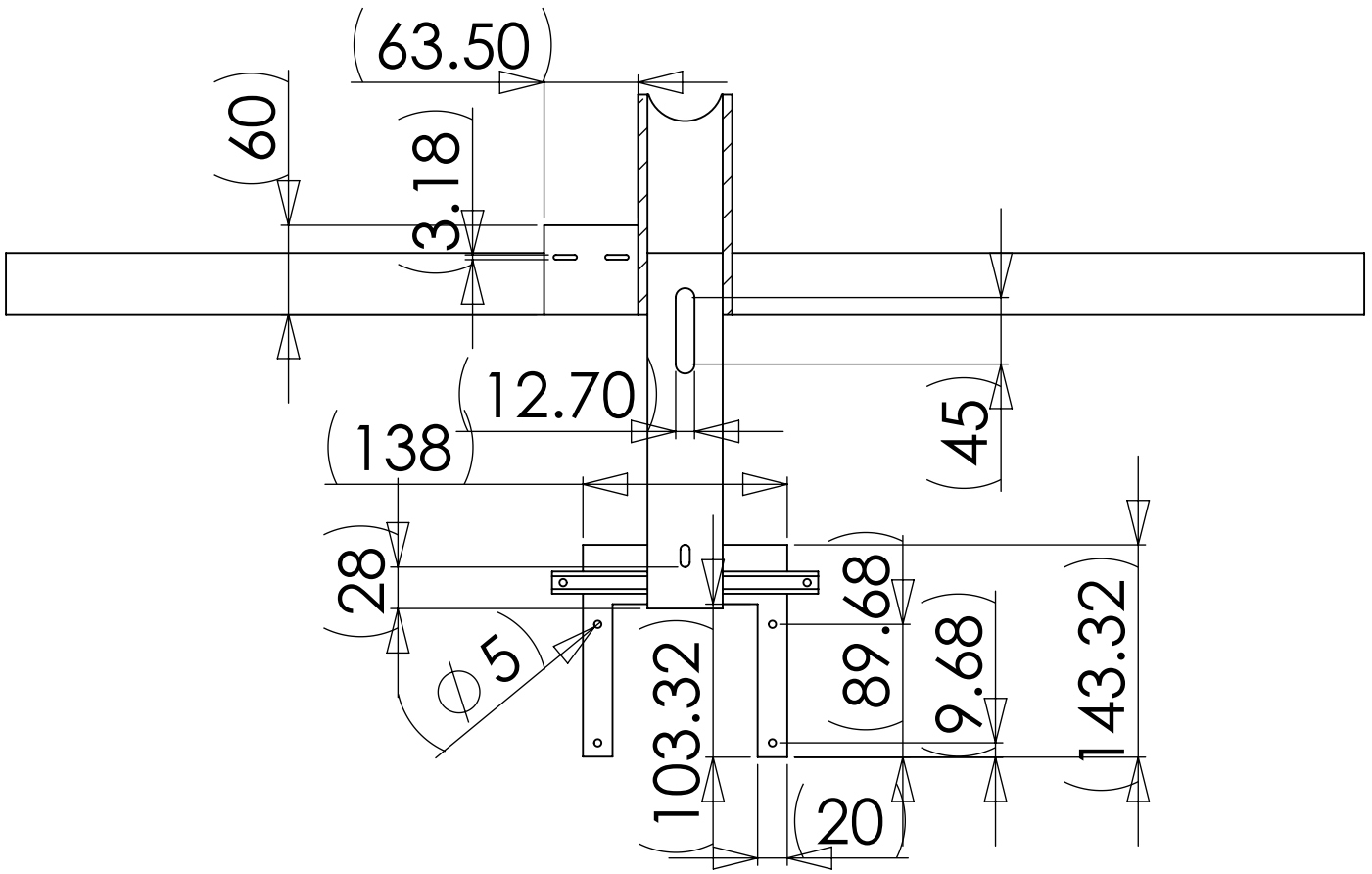

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		MATERIAL	COMMENTS:		
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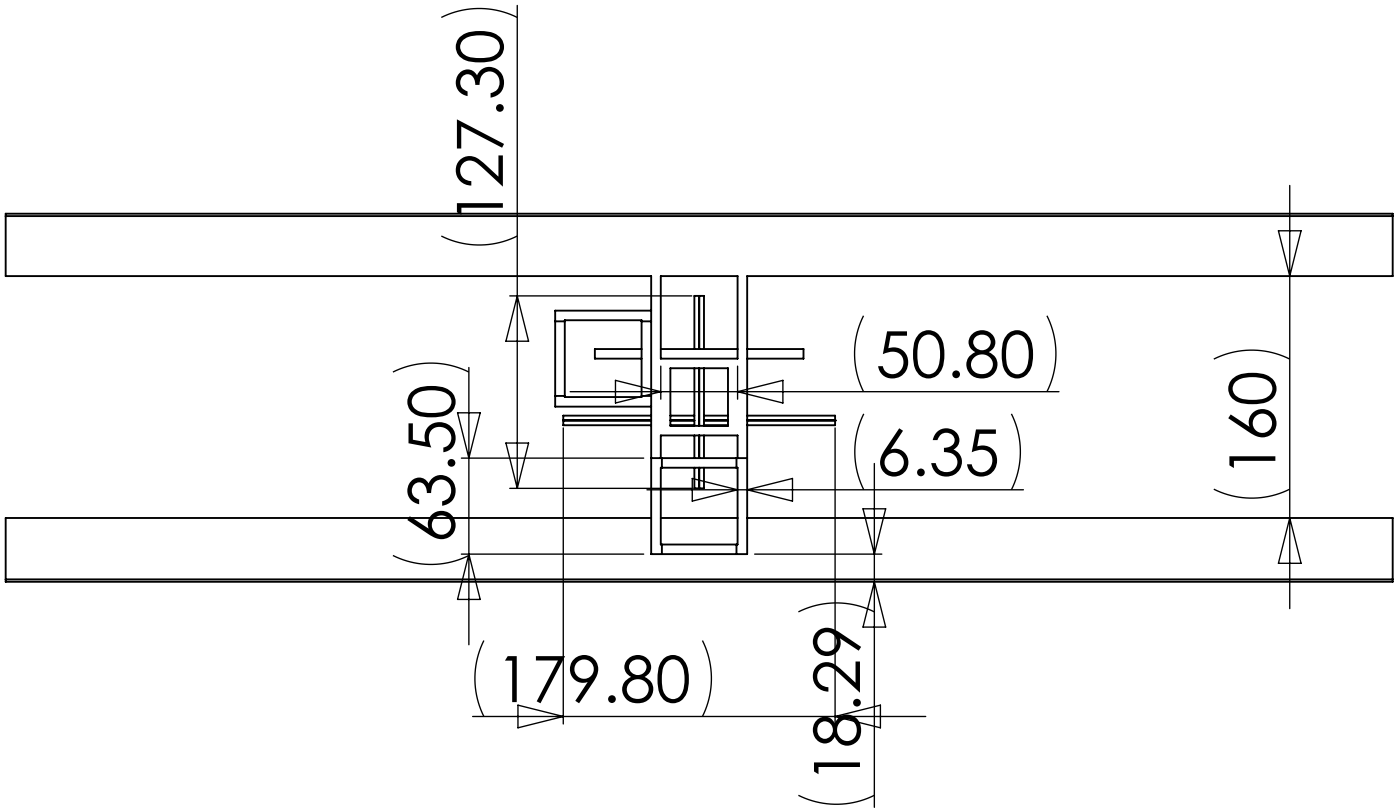
SIZE	DWG. NO.	REV
A	Support Beam, Support Be	
SCALE: 1:10	WEIGHT:	SHEET 3 OF 5

5 4 3 2 1



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		MATERIAL	COMMENTS:		
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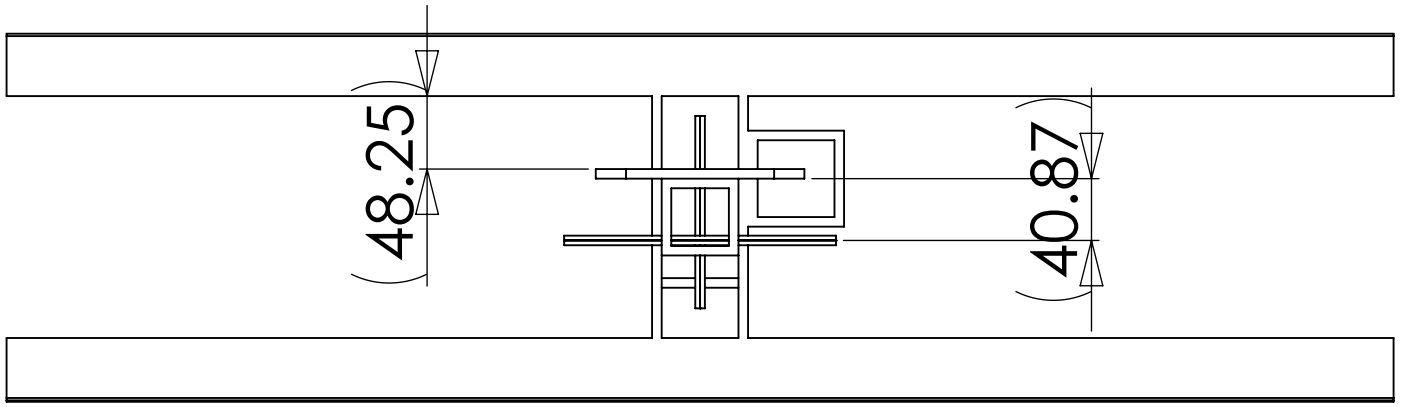
TITLE:

SIZE	DWG. NO.	REV
A	Support Beam, Support Be	
SCALE: 1:10	WEIGHT:	SHEET 4 OF 5

5 4 3 2 1



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		MATERIAL	COMMENTS:		
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TITLE:

SIZE	DWG. NO.	REV
A	Support Beam, Support Be	
SCALE: 1:10	WEIGHT:	SHEET 5 OF 5

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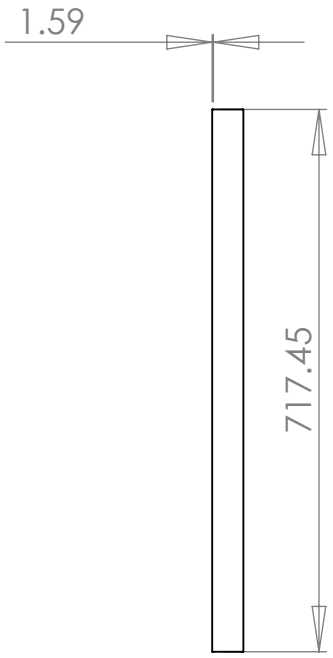

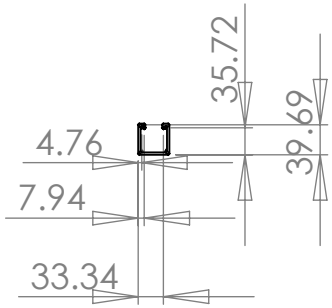

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BIRDIE

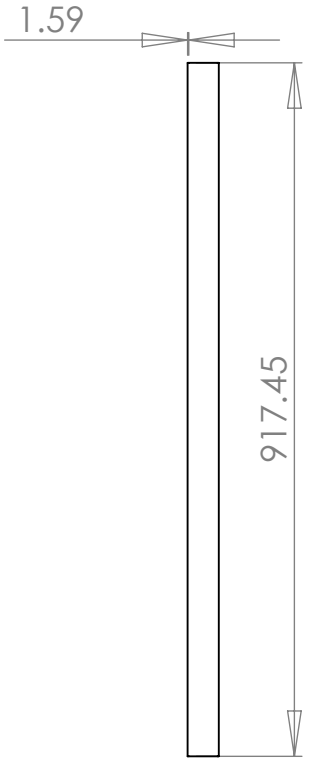
TITLE:

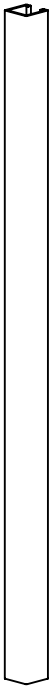
Test Structure, Uni .8 M

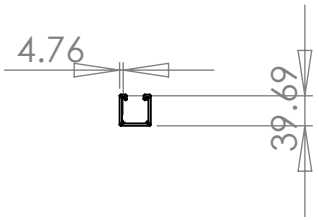
SIZE	DWG. NO.	REV
A		

SCALE: 1:20 WEIGHT: SHEET 1 OF 1

5 4 3 2 1







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		Tolerance (mm): .127	DRAWN		
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		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

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BIRDIE

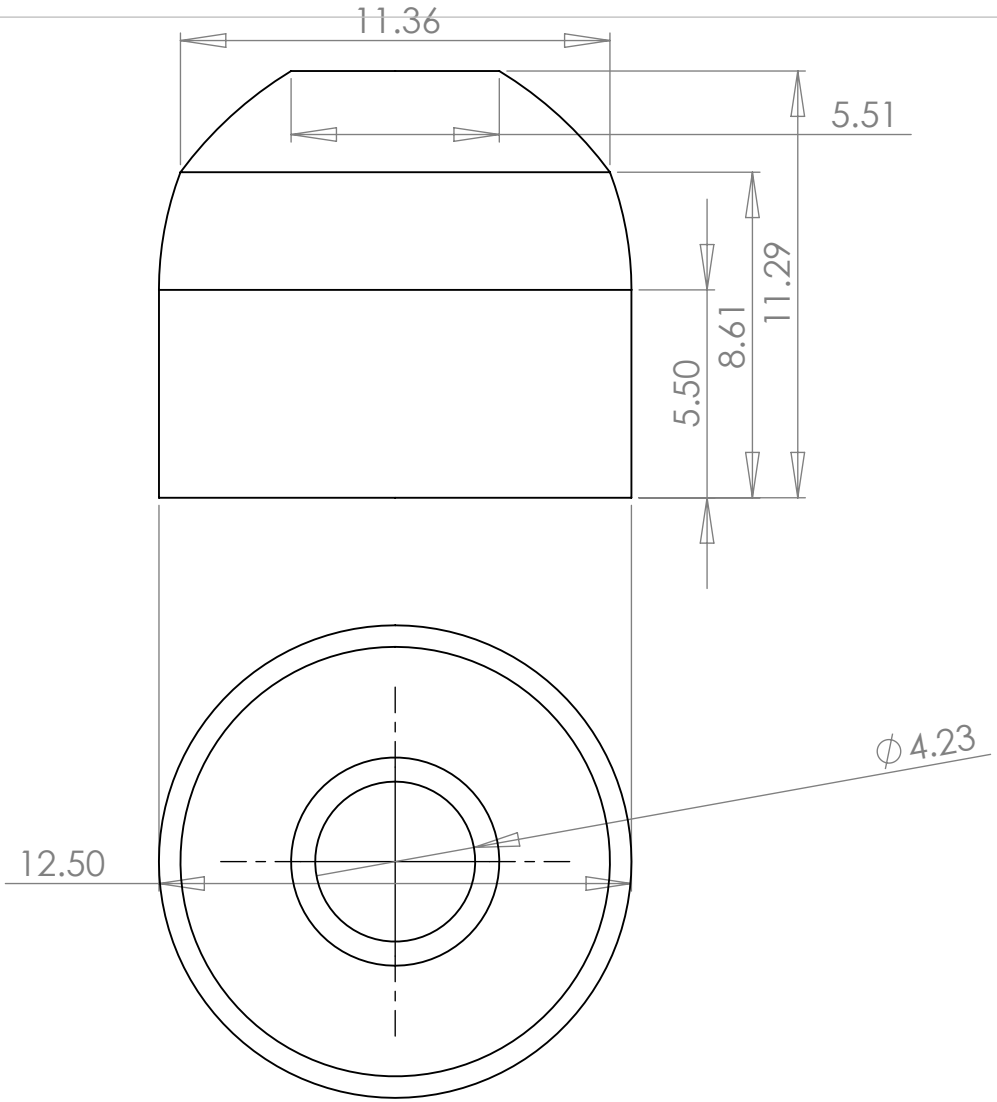
TITLE:

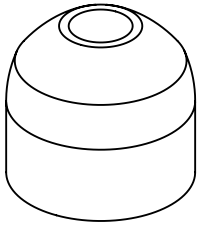
Teste Structure, Uni 1 M

SIZE	DWG. NO.	REV
A		

SCALE: 1:20 | WEIGHT: | SHEET 1 OF 1

5 4 3 2 1





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NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

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BIRDIE

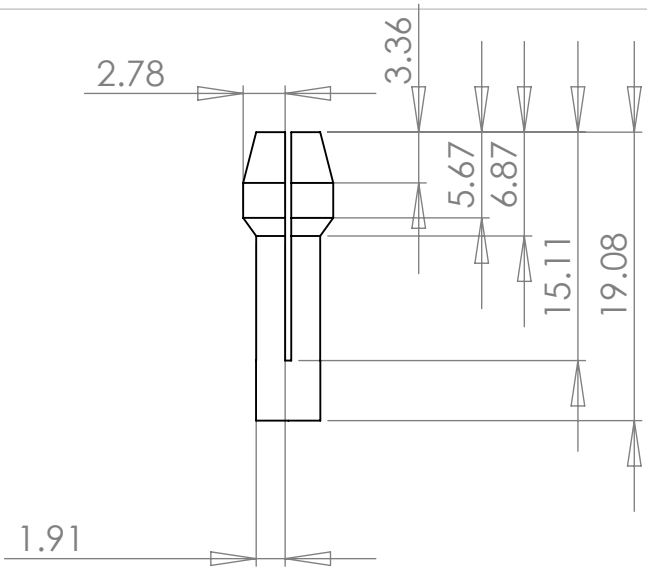
TITLE:

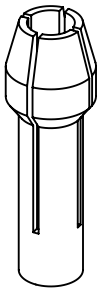
WLM, Collet Nut

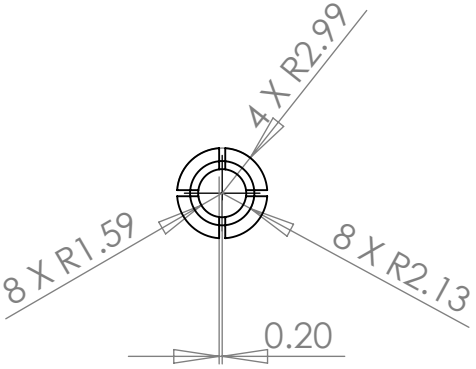
SIZE	DWG. NO.	REV
A	01-09-02	

SCALE: 5:1 | WEIGHT: | SHEET 1 OF 1

5 4 3 2 1







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		MATERIAL As Purchased	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

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BIRDIE

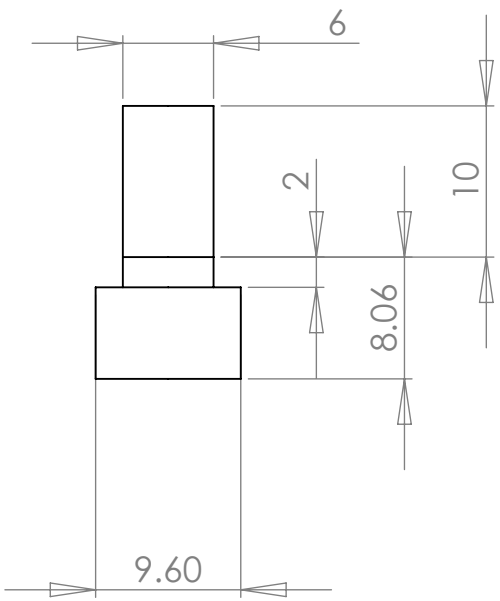
TITLE:

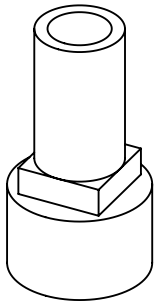
WLM, Collet

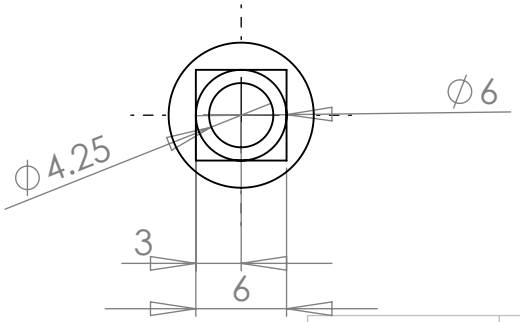
SIZE	DWG. NO.	REV
A	01-09-01	

SCALE: 2:1 | WEIGHT: | SHEET 1 OF 1

5 4 3 2 1







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BIRDIE

TITLE:

WLM, Rotarty Arm

SIZE	DWG. NO.	REV
A	01-09-03	
SCALE: 2:1	WEIGHT:	SHEET 1 OF 1

5 4 3 2 1

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Shannon Luminous Materials, Inc.
304 A North Townsend Street
Santa Ana, CA 92703
Tel: 714.550.9931

SECTION ONE -- IDENTITY INFORMATION

TRADE NAME : PHOTOLUMINESCENT PIGMENT

CAS NUMBER : NO

CHEMICAL/FAMILY NAME: ALKALINE EARTHMETAL ALUMINATE OXIDE

EUROPIUM DOPED

PRODUCT TYPE: PLO

FORMULA : $MO.Al_2O_3$:Eu

STATEMENT : THIS MATERIAL SAFETY DATA SHEET (MSDS) HAS BEEN

PREPARED IN COMPLIANCE WITH TIE FEDERAL OSHA HAZARD

COMMUNICATION STANDARD 29 CFR 1910.1200. THIS

PRODUCT IS CONSIDERED TO BE A NON-HAZARDOUS

SUBSTANCE UNDER THAT STANDARD.

SECTION TWO -- HAZARDOUS INGREDIENTS

INGREDIENTS GAS NUMBER % ACGIH-TLV OSHA-PEL

AS INERT DUST (TOTAL) $2mg/m^3$ ACGIN-TLV

$3mg/m^3$ OSHA-PEL

SECTION THREE -- PHYSIGAL DATA

APPEARANCE : LIGHT-GREEN POWDER/NO ODER

MELTING POINT : DISSOCIATES 1200^0 C

VAPOR PRESSURE: N/AP

VAPOR DENSITY : N/AP

SOLUBILITY IN WATER : SOLUBLE

WEIGHT PER CUBE METER: 3.0 - 3.6

PLAMMABILITY CLASS: N/AP

EXTINGUSHING MEDIA: WATER

SPECIFIC GRAVITY: 3.0 - 3.6

FREEZING POINT : N/AP

PERCENT VOLATILE: N/AP

EVAPORATION RATE: N/AP

PH (% IN WATER) : N/AP

FLASH POINT : N/AP

AUTO-IGNITION TEMP: N/AP

FIRE FIGHTING PROCEDURE-SPECIAL

FIRE FIGHTERS SHOULD WEAR SELF-CONTALNED BREATHING APPARATUS

WHEN FIGHING CHEMICAL FIRES.

USE WATER SPRAY TO COOL NEARBY CONTAINTERS AND STRUCTURES EXPOSED

TO FIRE.

UNUSUAL FIRE AND EXPLOSION HAZARDS:

THIS PRODUCT WILL NOT BURN.USE APPROPRIATE TECHNIQUES TO FIGHT

SUROUNGING FIRE.

SECTION FOUR -- REACTIVITY DATA

STABILITY: STABLE

HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

CONDITIONS TO AVOID: CONTACT WITH ACIDS

INCOMPATIBILITY : CONTACT WITH ACIDS

HAZARDOUS DECOMPOSITION PRODUCTS: WILL NOT OCCUR

SECTION FIVE -- HEALTH HAZARD DATA

RESPIRATORY EQUIPMENT: LOCAL EXHAUST/MECHANICAL (GENERAL)

PROTECTIVE GLOVES: PLASTIC OR NEOPRENE

EYE PROTECTION: CHEMICAL GLASSES

VENTILATION:

OTHER PROTECTIVE EQUIPMENT: LAB COAT

THRESHOLD LIMIT VALUE: OSHA, PEL TOTAL DUST $3mg/m^3$

PRIMARY ROUTES OF EXPOSURE: INHALATION/INGESTION/SKIN

OSHA PEL : $3mg/m^3$

ACGIN TLV: $2mg/m^3$

EFFECTS OF OVEREXPOSURE: MAY CAUSE IRRIATION TO EYES,SKINS &

MUCOUS MEMBRANES

LISTED CARCINOGEN: NONE

SECTION SIX -- EMERGENCY & FIRST AID DATA

SKIN: WASH OFF WITH SOAP & WATER

EYES: FLUSH WITH WATER FOR 5 MINUTES

INHALATON: REMOVE TO FLESH AIR

INGESTION: DRINK QUANTITIES OF WATER & INDUCE VOMITING

SECTION SEVEN -- TOXICOLOGY INFORMATION

THIS PRODUCT IS OF NON-TUXIC,PLEASE CONTACT THE MANUFACTURE FOR

FURTHER INFORMATION.

SECTION EIGHT – SPILL OR LEAK PROCEDURES

SPILL PROCEDURES: WEAP APPROPRIATE PROTECTIVE EQUIPMENT, AVOID

THE GENERATION OF DUST, VACUUM OR SHOVEL

MATERIAL AND PLACE IN CLOSABLE CONTAINER(S)

FOR DISPOSAL

WASTE DISPOSAL METHODS: DISPOSE IN ACCOURDANCE WITH STATE AND

LOCAL REGULATIONS

SECTION NINE -- REGULATORY INFORMATION

SARA 313 TITLE III

TOXIC SUBSTANCE CONTROL ACT (TSCA):

ALL INGREDIENTS IN THIS PRODUCT ARE LISTED ON THE U.S. EPA TSCA

INVENTORY OF CHEMICAL SUBSTANCES.

SECTION TEN -- SPECIAL PRECAUTIONS FOR INDUSTRIAL USE ONLY

HANDLING & STORAGE INFORMATION:

STORE CLOSED IN COOL DRY AREA WHEN HADLING WEAR PROTECTIVE

CLOTHING & RESPIRATORY PROTECTION. AVOID SCATTER INTO THE AIR.

OTHER PRECAUTIONS: MAINTAIN A SCHEDULE OF REGULAR HOUSEKEEPING

TO INSURE CLEANLINESS

SECTION ELEVEN -- ADDENDUM

DEFINITIONS AND ABBREVIATIONS:

ACGIH=AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS

CAS=GHEMIGAL ABSTRACTS SERVICE REGISTRY HUMBER

EPA=ENVIRONMENTAL PROTECTION AGENCY

N/AP=NOT APPLICATION

N/AY=NOT AVAILABLE

NOISH=NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

OSHA=OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION

PEL=PERMISSIBLE EXPOSURE LIMITS

SARA=SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT

Cl

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